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Electrical energy allocations at Navy and Marine Corps bases

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ELECTRICAL ENERGY ALLOCATIONS AT NAVY AND MARINE CORPS BASES

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THESIS

ELECTRICAL ENERGY ALLOCATIONS
AT NAVY AND MARINE CORPS BASES

by

Alexander Shalar

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Navy and Marine Corps bases in the continental United States derive almost all of their electricity from public utility companies. For this thesis, the conditions of service of select public utility companies in one part of the United States, the West Coast, were investigated. Particular attention was devoted to the utility companies' plans to allocate electricity to their customers if an emergency or a fuel shortage should occur.

The second major area investigated was the internal management of electricity within Navy and Marine Corps bases. The load shedding plans of about 80 bases were reviewed, and from these, guidelines were developed for the preparation of an optimal load shedding plan. Also, a unique approach to electrical allocation was developed. The approach is based on the utility theory of economics.

Finally, investigation was conducted into the potentials of central process controllers, which are solid state electronic devices designed to provide improved controls over energy consuming systems.

Electrical Energy Allocations

at Navy and Marine Corps Bases

by

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ABSTRACT

Navy and Marine Corps bases in the continental United States derive almost all of their electricity from public utility companies. For this thesis, the conditions of service of select public utility companies in one part of the United States, the West Coast, were investigated. Particular attention was devoted to the utility companies' plans to allocate electricity to their customers if an emergency or a fuel shortage should occur.

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I. INTRODUCTION

For many years, scientists, engineers and others working in the energy field had been issuing warnings regarding the rapid depletion of the world's energy resources. Intending to set an example for other to follow, the President of the United States issued an order on 29 June 1973 directing all Federal Agencies to curtail energy usage by 7%. Taking into account a historical growth in electrical consumption of about 3% per year among Federal Agencies, the net effect of the reduction was to be 10%.

Subsequently in October 1973, with the start of the Arab oil embargo, all segments of the population were affected by the "energy crisis." In order to conserve fuel, people were requested to drive at slower speeds, reduce thermostat settings, decrease lighting levels, and limit the use of electricity consuming equipment. The possibility existed that electrical utility companies would reduce the amount of power they provided their customers. Since military installations in the United States derive almost all of their electricity from public utility companies, there was a possibility that they might be adversely affected by utility company reductions.

It is the intent of this thesis to investigate the extent to which select public utilities companies might reduce, or allocate, electric power to Navy/Marine Corps bases. Also, It is intended to investigate allocation plans within certain

Navy/MC bases and to propose a general model for the development of allocation plans for Navy/MC activities. Finally, consideration will be given to the use of electronic devices that are presently available which might be used to make energy management more efficient.

Due to time constraints, the extent of research was limited to the following:

1. Mailing of 103 questionnaires to Navy/Marine Corps (Navy/MC) bases throughout the continental U.S.

2. Mailing of questionnaires to 14 utility companies in the Western States.

3. Mailing of questionnaires to 14 organizations representing the private sector in various parts of the U.S.

4. A field trip to one of the Navy/MC installation (MCAS El Toro, California).

5. A field trip to Fashion Village, Orange, California, to observe the operation of a central process control system, (Honeywell Delta 2000).

6. A field trip to the Southern California Edison Company.

7. Numerous discussions with Navy/MC Corps representatives, and individuals in the private sector.

8. Material included in the attached bibliography and other material.

It is regretted that coverage of utility companies serving more Navy/MC bases in the U.S. was not possible, however, it is believed that the data in this thesis will be representative of data for many utility companies throughout the country.

The approach that will be taken is the following:

Chapter I is this introductory chapter.

Chapter II provides some background information regarding the nation's energy requirements, the availability of resources to produce energy, Navy/MC needs for energy, and the increasing prices paid by Navy/MC for electrical energy.

Chapter III describes the process used by public utility companies to allocate electricity to their customers, including Navy/MC bases, and the possible consequences resulting from the dependency of Navy/MC bases on public utility companies.

Chapter IV deals with allocation practices within the Navy/MC. A simple form of allocation, load shedding, is discussed. Then a more theoretical approach to the allocation process is introduced. The important elements of an effective utilities conservation organization are also discussed.

Chapter V deals with electronic devices called process control centers which provide improved controls over large electrical consuming equipment and systems. Process control centers also have direct applicability to load shedding and energy allocation processes.

Chapter VI summarizes the preceding chapters and conclusions are reached with regard to allocation of electricity by public utility companies, and allocation of electricity within Navy/MC bases.

II. PROBLEMS IN THE SUPPLY AND DEMAND OF ELECTRICITY

The energy problem is primarily an economic problem and its resolution requires the study of both the demand and supply side of the economic equation.

A. THE DEMAND FOR ENERGY

The demand for energy is going up at a dramatic rate, both in the United States and abroad. The reasons are:

- A growing population;
- An increased per capital consumption; and
- An ever growing and more energy intensive economy.

In the United States, while the nation's population is expected to grow by 50 percent between now and the year 2000, our energy demand is predicted to double by 1990, and nearly tripple by the year 2000. This rate of growth in demand is not restricted to the U.S. but is expected to be equally great in some of the other industrial countries of the world.

The following statistics more clearly describe the present, and the future energy requirements in the United states: /Ref. 28/

YEAR 1970

Total Energy Uses: 66×10^{15} BTU

Source		Uses	
Nuclear and other	4%	Direct combustion	76%
Coal	22%		
Oil	42%	Electric generation	24%
Gas	32%		

YEAR 2000 PROJECTIONS

Projected Energy Use: 150×10^{15} BTU

Sources		Uses	
Nuclear and other	23%	Direct combustion	57%
Coal	14%		
Oil	36%	Electric generation	43%
Gas	27%		

The above figures indicate that the forecast for the year 2000 is for nearly ¼ of all energy to be nuclear. Also, the use of energy for the production of electricity is expected to increase dramatically, indicating a more electricity-dependent society.

A complicating factor in the increased demand for energy nationally in the 10 years 1963 through 1972, was the shift

in the types of sources of energy that were demanded. The 5-7% increase in annual demand during that period does not tell the whole story. Environmental considerations strongly influenced the demands for various types of energy sources. Some of these follow:

- Natural Gas offers "clean combustion," but because it is rapidly nearing depletion in the U.S., (some forecasters were predicting depletion by 1985 if rate of use was not curtailed), industries and utility companies are converting to other energy sources which are expected to be less costly in the long run.

- Coal is the most abundant energy source in the U.S. but it is becoming more difficult to extract it from conventional mines. Also, conventionally mined coal usually has high sulfur content which causes pollution limits to be exceeded in most areas of the country. In Colorado and some of the other Rocky Mountain States there exists an abundance of low-sulfur coal. Strip-mining would be required for recovery to be economically feasible. However, there is strong opposition to strip-mining from local residents based on fears that the land will be irreparably damaged. /Ref. 38/ In any case, the uses of coal in its solid state are limited, e.g. automobiles cannot run on coal. Intensive research and development is being conducted on the gasification and liquefaction of coal.

- Oil. Except for oil from certain parts of the world, i.e., Lybia, Nigeria, and Indonesia, much of the world's oil is high in sulfur content. Although various "scrubbers" and other devices have been developed to remove the sulfuric pollutants passing through industrial smokestacks, a device that is 100% reliable (and reasonably economical) has not been developed yet. And the availability of naturally low-sulfur oil is limited. The demand for oil has increased dramatically in the U.S. in the past 10 years partly due to increased consumption by automobiles which now account for about 28% of all oil used. Consumption has increased dramatically due to the anti-pollution devices that have had to be added. Automobiles consume up to 40% more gasoline per mile travelled today than they did 10 years ago. Lastly, the importance of oil as a raw material for numerous industries should be mentioned. It is used in plastics, fertilizers, chemicals, and a great many other products.

- Nuclear Power Plants. Although air pollution is non-existent with these plants, they must be built where there is a large supply of water for cooling purposes. In some cases there has been environmental opposition because of ecological changes that might occur from the warmer water returning to its source, even though no radiation is added to the water, e.g. opposition to building a nuclear plant on the Hudson River in New York several years ago. A more serious problem which defies resolution to this day, is the problem of how to dispose of radioactive waste. Periodically, a nuclear reactor's core has to be cleaned out. The waste material has a radioactive half-life of several thousand years, meaning that it loses half of its radioactivity in that period of time. At that rate, it would take many thousands of years for the waste material to become harmless to living things. A process to speed up half life has not been developed as yet. Disposal of radioactive waste in the ocean or in space has been ruled out as unacceptable. For now, such waste is stored in remote desert areas. However, even with this procedure, there is the possibility of contaminating underground water, and at some time, the amount of waste is bound to exceed the limits of "safe" storage. Nevertheless, the demand for nuclear energy (mostly for electrical generation) is expected to increase dramatically (from 4% in 1970 to 23% in the year 2000 - see previous chart).

In order to put DOD energy uses in proper perspective, the following statistics are offered: [Ref. 28]

TOTAL DOD ENERGY USE EXCLUDING NUCLEAR AS A % OF NATIONAL USE (CY-74 est.) ---2.4%

DOD Energy use by source (FY-74 est.)-

Petroleum	72.5%
Electricity (purchased)	16.6%
Natural gas and propane	7.2%
Coal Purchased steam and hot water	.2%
Total	100.0%

DOD Energy Demand by Operational Function (FY-74 est.)-

Aircraft operations	44.7%
Installation support	39.0%
Ship operations	11.4%
Ground operations	4.9%
Total	100.0%

The following additional comments are offered with regard to the above:

- Most of the electricity used by DOD is purchased from public utility companies.

- Navy/MC aircraft operations account for only about 1/3 of the total DOD consumption.

- Whereas installations (buildings, airfield lighting, etc.) consume 39% of the energy now, DOD projections for 1979 are that this figure will increase to be almost equal to the Aircraft operations figure. /Ref. 28/

The DOD and Navy/MC approach to the energy problem is to analyze all sources of energy, not just oil and its derivatives. For many years, the Navy/MC uses of energy sources have been tracked through the UCAR (Utilities Cost Analysis Report). With the added emphasis placed on energy as a result of the President's 29 June 1973 directive, the Navy/MC initiated the use of another report, the Energy Consumption Data Report. This is a computerized report based on data submitted by Navy/MC bases in the following format:

Purchased electricity

Natural gas and propane

Fuel oil

Coal

Purchased Steam/Hot Water

Transportation Distillate Fuels

Transportation Motor Gasolines

A DOD report, named the Defense Energy Information system (DEIS) Report, was also initiated as a result of the President's directive. All military installations submit DEIS reports to DOD on a monthly basis. The format is somewhat different from the format of the Navy/MC Energy Consumption Report, but the end result is also that all forms of energy used by the bases are covered in the report.

For the Navy/MC the highest single utility cost in FY-72 was the cost of electricity, which accounted for $108.5 million, or 42% of total utility costs. At that time national per capita consumption was increasing at 5.6% per year as compared to the Navy/MC's 3.6% per year. However, Navy/MC planners were forecasting an increased rate in electrical consumption due to additional automation, cold iron support* and technological improvements, among other reasons /Ref. 9/. Although conservation measures in the past two years have resulted in reduced consumption of electricity, it can be expected that the trend over the long run will revert to an increasing rate of consumption, unless economic pressures, i.e. higher cost of energy, drive down consumption.

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* Cold iron - A Navy term meaning providing berthed ships with shore electricity, steam, water and other utilities.

B. THE SUPPLY OF ENERGY

The United States possesses sufficient energy resources to be self-sufficient beyond the year 2000. Coal reserves alone are estimated to be adequate to meet total energy needs for 300 years. There are vast untapped shale oil reserves as well. The problem is that our entire mode of living is structured around our least plentiful resources - oil and natural gas - while our most abundant resources are used least. The seriousness of the situation not only in terms of U.S. resources, but those of the world, was expressed by Congressman Mike McCormack, Chairman of the House Task Force on Energy in an article published on 2 April 1973, in which he said: [Ref. 15]

> "Of greater concern, we have never really faced the fact that no matter whose oil and gas we attempt to use first, we will certainly have used up virtually all domestic and foreign oil available to us by the end of the century, and all available gas at an earlier date."

In a slightly more optimistic prediction, the Atomic Energy Commission shows the rate of oil extraction worldwide beginning to decrease some time between 1990 and 2000, with virtual depletion occurring aroung the year 2075 [Ref. 12].

There have been some dramatic events with regard to energy in the past two years. The first was the formation of the Organization of Petroleum Exporting Countries (OPEC), an association of the 13 major oil exporting countries of the world.

Second was the six-month Arab Oil embargo on the United States and other countries (October 1973-March 1974).

Although the U.S. had been dependent on Arab countries for only 6 to 12% of its oil needs, the sudden elimination of this source from the supply stream was felt throughout the country, resulting in an odd-even day gas sales scheme, shortage of home-heating oil in some states, etc. This event, more than any other, swayed U.S. public opinion away from preoccupation with environmental issues, to interest in accelerating exploration and developemnt of power sources within the nation. As a result, projects which were being delayed for environmental and other reasons, e.g. Alaska pipeline (delayed for 3 years), scores of nuclear power plants, off-shore oil drilling, and other projects got back on track. Since the lifting of the embargo, however, public interest in accelerating development of national energy resources has begun to wane once again.

The third major event of the past two years was the increase of oil prices charged by the OPEC countries. From a price of $2.59 per barrel in early 1973, prices were systematically raised by substantial amounts every few months, until reaching a price of $10.46 in 1974. This represents a greater than 300% increase in less than 2 years. The enormous quantities of oil sold have resulted in billions of dollars being transferred from the oil consumers to the OPEC countries.

In a speech at the World Energy Conference in Detroit on 23 September 1974, President Ford spoke of the consequences of skyrocketing oil prices: [Ref. 25]:

"We recognize the desires of the producers to earn a fair share or a fair price for their oil as a means of helping to develop their own economics. But exorbitant prices can only distort the world economy, run the risk of a worldwide depression, and threaten the breakdown of world order and safety."

U.S. payments for oil imports rose from $4.7 billion in 1972 to about $25.8 billion in 1974. /Ref. 25/

Another effect of the increased cost of imported oil was that it now cost less to extract U.S. domestic oil than to import oil. Consequently, the impetus is to use more domestic oil, thereby depleting that resource faster than before. The U.S. Bureau of Mines estimates that whereas oil accounted for 32% of total U.S. domestic energy production in 1970, it will account for 43.7% in 1975. /Ref. 25/

The price of electricity has been affected in varying degrees by the increase in oil prices. For instance, in the Pacific Northwest, the primary energy source is hydroelectric, thus changes in oil prices had essentially no effect on the price of electricity. By contrast, utility companies in Southern California are heavily dependent on oil. In some instances, electrical rates in that part of the country more than doubled in two years. (This survey was limited to West Coast utility companies. It is understood, however, that even higher price increases were experienced in some other parts of the country.)

Normally, public utility company rates change infrequently, and changes are effected only after formal public hearings in which people and organizations opposed to the change have a chance to be heard. However due to the rapidity of

escalation of fuel prices, the Public Utility Commission in California has allowed utility companies under its jurisdiction to add a "Fuel Cost Adjustment" to their billings without public hearings. Thus, for example, the Southern California Edison Company raised its rates 13 times in a little over two years, with the benefit of only one public hearing. Almost all of the rate increase, from 1.02¢/KWH (June 1972) to 2.43¢/KWH (June 1974), at MCAS El Toro was due to Fuel Cost Adjustments. The curtailment of public hearings removed one of the important controls limiting utility rate increases.

Appendix A gives data on costs of electricity for five Navy/MC bases which are served by five different public utility companies. The following are some observations regarding the statistics:

1. In June 1972, the Navy base at Skaggs Island, California paid the lowest rate of all five bases - .98¢/KWH (PG&E). By June 1974, the rate had increased to 1.44¢/KWH, a 47% increase in two years.

2. The largest average rate increase in the two year period was experienced by NWS Seal Beach, California-110% increase, from 1.15¢/KWH to 2.42¢/KWH (San Diego Gas and Electric Company).

3. The largest increase in yearly expenditure for electricity also occurred at NWS Seal Beach, California-from $120,662 to $298,984, a 148% increase in FY-74 cost over FY-72 cost.

4. The greatest reduction in electrical consumption was achieved by MCAS El Toro, - 36% in two years (Southern California Edison Company). Nevertheless, total electrical cost increased by 26% (from $649,850 to $820,563), despite the substantial reduction in consumption. The rate charged MCAS El Toro more than doubled in two years.

5. The only reduction in rates occurred at NAS Whidbey Island, Washington (Puget Sound Power and Light Company) where the rate went from 1.1¢/KWH (June 1972) to .95¢/KWH (June 1974), a 13% decrease. The main energy source for electricity in this area is hydropower, which accounts for the non-escalating utility rate.

The Naval Facilities Engineering Command recently promulgated some new guidelines to be used in economic analyses for justifying energy conservation projects. Under these guidelines, bases submitting projects are to use 25% annual electrical cost escalation in their calculations. This new figure supersedes the previous guidelines to use 10%. One of the significant effects of rapidly escalating electrical costs, is that they have taken increasing portions of the operations and maintenance budgets of many Navy/MC bases. See Appendix C for some examples. Funds diverted to pay for increased utility bills result in less station maintenance being accomplished. Inasmuch as most base maintenance budgets are austere to begin with, any unexpected expenses such as the utility cost increases can have a severe impact on the upkeep of the base.

A specific problem area was described in the 15 October 1974 CEC Biweekly Report as follows: [Ref. 4]

"<u>Shortfalls in Housing Operation Funds.</u>

"There is a serious shorfall in Navy housing operations funds, primarily due to large utility cost increases since our 1973 submission of the fiscal year 1975 budget. There is no mechanism for augmenting family housing funds since resources are specifically compartmentalized in legistation, and prospects for a supplemental appear dim. We must plan to operate our housing within currently available resources."

The article goes on to say that family housing has the poorest prospect for savings through utilities conservation efforts, and suggests other means of effecting savings, e.g. defer maintenance, reduce normal services such as garbarge pickups, etc.

The following conclusions are drawn from the data presented in this chapter:

1. The days of inexpensive energy are gone, unless there is some significant technological breakthrough.

2. The U.S. will continue to depend on foreign oil mostly because of rapidly depleting U.S. reserves and current inability to use substitute energy sources to a greater extent.

3. Electric utility companies which depend on foreign oil - (a) run the risk of being affected by another embargo, and (b) can expect their operating cost to rise rapidly as long as they are dependent on oil.

4. Since most Navy/MC bases are dependent on public utility companies, they are subject to - (a) possible curtailments of electric power, and (b) increasing prices of electricity.

III. ALLOCATION OF ELECTRICITY TO NAVY/MC ACTIVITIES BY PUBLIC UTILITY COMPANIES

A. THE PUBLIC UTILITY COMPANY ALLOCATION PROCESS

Data relative to electrical management and allocation was obtained from a half dozen of the companies which serve Navy/MC bases in the Western States. Due to time constraints, it was not possible to include utility companies in other parts of the United States in the survey.

In response to questionnaires, all companies stated that it was not possible for them to reduce power supplied to the bases by a specific amount, i.e., 10%, 20% 30%, etc. For the most part, most companies had allocation plans similar to one published by the Sierra Pacific Power Company of Reno, Nevada [Ref. 30]. Portions of the plan are presented herein. When other sources are cited, credit will be given as appropriate.

In the plan, there are three categories of electrical curtailments:

1. Voluntary: The first step is a plea to the public through advertising and public statements for the voluntary curtailment of the use of electricity during a fuel supply crisis (or other emergency situation). The second step for the voluntary phase is a more specific form of voluntary participation in which electric company engineers and technicians visit large electrical users and suggest methods of voluntary curtailment. One of the outcomes of such visits is the "Customer Contact Form-Emergency Voluntary Electric Load Reduction." In this form, the customer indicates his peak demand, and the amount of load (in KW's) that he can be counted on to reduce voluntarily for various timeframes: 1-8 hours, 8-24

hours, 1-7 days and indefinitely. With this information, the utility company can calculate the approximate amount of reduction that can be expected through the voluntary curtailments of large customers.

2. Mandatory: This type of curtailment may be directed at specific customers or specific types of uses and must have prior approval of the State Public Utilities Commission before it can be implemented by a Utility Company. An example is cited where in England, during their recent fuel crisis, certain non-essential industries were ordered closed for day periods. Although such extreme measures were not taken in the U.S., there were prohibitions against certain types of uses of electricity. For example, California Public Utilities Commission Decision No. 82305, Case No. 9581, dated January 3, 1974, concurrent with ordering a 10% reduction in the generation of electricity by utility companies, restricted consumer's uses of electricity with respect to outdoor advertising and decorative lighting, functional outdoor lighting, comfort heating and cooling, outdoor public gatherings and indoor business lighting. Specific examples of restrictions include the following:

   - use of only one lighted outdoor sign by business establishments;

   - prohibited building floodlighting, lighting of billboards and operation of other types of advertising devices;

   - prohibited outdoor lighting of car sales lots, gas stations and the like when not open for business;

   - required businesses which are open during hours of darkness to reduce electrical consumption by 50%;

   - limited commercial and industrial establishments using electricity for heating and cooling to temperaturees of 68°F (max.) for heating and 78°F (min.) for cooling;

   - required customers engaged in recreational or cultural activities to reduce their electrical consumption by 15%;

   - prohibited indoor business lighting during non-business hours, except limited lighting for janitorial and security purposes.

   Subsequently, because voluntary reductions had been so successful and because the Arab oil embargo had

been lifted, California PUC Decision No. 82881 of 15 May 1974 was issued easing many of the previous restrictions. This Decision retained the 10% reduction goal for medium to small bases but raised the goal for large bases to the 15%-20% range. (DOD requirements for FY-75 are for 15% reduction at all installations based on FY-73 consumption.)

3. Involuntary or Sequential Rotation: While sometimes referred to as "brownouts" or "blackouts," these are better described by the term "rolling blackout." Brownouts (reductions in voltage) have been determined by most companies in the Western States as not to be an effective means of reducing fuel consumption due to transformer losses, etc. Also, some of the utilities systems are not designed in such a way as to make brownouts possible. A rolling blackout, i.e. certain circuits out for certain priods of time in a given sequence with public notice, are the basis of the involuntary plan.

As an example of one approach, the implementation of the rolling blackout concept by the Southern California Edison Company involves the dropping "blocks" of customer-loads in roughly 100,000 KW increments on a rotating basis for one hour periods. There would be prior notice through widespread announcements over the news media. Certain customers, i.e. hospitals, water works, fire stations, police department (but not military installations, as of the initial draft of the plan), would be exempt from the rolling blackout.

All of the utility companies contacted stressed that it was extremely unlikely that they would have to resort to a rolling blackout. In fact, a representative of the Southern California Edison Company, (one of the three largest utilities on the West Coast), stated that a rolling blackout contingency plan did not even exist in his company prior to the recent "energy crisis."

B. POSSIBLE CONSEQUENCES OF DEPENDING ON PUBLIC UTILITY COMPANIES FOR ELECTRIC POWER

1. The Worst Case to Occur in the Western States During the Arab Oil Embargo

The most drastic measures taken by any large utility company in the Western States during the recent oil embargo were those taken by the Department of Water and Power of Los Angeles. The DWPLA, being a fairly small utility company, was seriously affected by the oil shortage, therefore, it instituted a policy wherein its customers were required to reduce consumption by 15%. Violators were fined 50% of their bill on the first violation. On the second violation, their power was cut off for 2 days. Fortunately, there were no Navy/MC bases dependent on DWPLA at the time of the embargo, nor are there any as of the time of this writing.

2. Massive Blackouts

Another concern of this writer was the possibility of massive uncontrolled blackouts, such as the well-publicized blackouts covering several Northeastern States in 1965 [Refs. 1, 11]. On the West Coast, as in the Northeast there exists a power grid, or pooling of systems. The various utility companies' systems are interconnected in order to provide the flexibility of carrying portions of one anothers' loads on those infrequent occasions when it is advantageous to do so. The power systems on the West Coast are tied together extending the length of the coast, from below San Diego, to above Seattle.

The problem in the Northeastern States in 1965 stemmed from the fact that, although the systems were interconnected, there was a limit as to how much of a load each adjoining system could pick up from its "neighbor," and the "grid" was not designed to handle overloads. As a consequence, there was a "domino" effect of one system after another failing totally because it was unable to pick up the preceding load. The result was popularly described as "The Great Northeast Blackout."

The recurrence of such an event is not possible in the Northeast nor on the West Coast because protective equipment, consisting mostly of over-current, under-voltage and other kinds of relays, has been added which allows adjoining systems to pick up loads but at the same time shed loads that they are incapable of handling.

Due to the interconnection of systems, and the reserve capacity of each individual system, electrical service offered to Navy/MC bases on the West Coast is extremely reliable.

3. Lack of Capacity

Prior to the oil embargo, most electrical utility companies' expansion plans were based on a 7% per annum increase in consumption. This meant that a company's generating capacity would have to be doubled every 10 years. This in turn meant that a considerable amount of money had to be obtained for what was essentially a continuous expansion program. With the high cost of money brought on by

inflation, many companies were worried about being able to keep pace with the requirement for new generating capacity.

Another problem which the utility companies faced was difficulty in getting approval for new plants and major expansions. A Southern California Edison representative told this writer that a conventional plan could require the review and approval of 30 different agencies of local, state and federal government, while for a nuclear plant, over 40 agencies could become involved. Because of this, the planning stage under normal conditions could be expected to take 3 years for a conventional plant, and upwards of 7 years for a nuclear plant.

A factor of increasing influence in recent years has been the representation of environmentalist groups at the public hearings. These groups could be represented and have a voice in each of 10 or 20 public hearings which take place during the approval process, and frequently have an influence on the length of time that is required to get final approval. In some cases, they have succeeded (for better or for worse) in completely blocking approval of a project, thereby resulting in cancellation of the project.

In a sense, the recent oil embargo was a boon to the planners. Conservation efforts by the population have resulted in a reduction in consumption (KWH's). Thus, the Southern California Edison Company, for example, has reduced its planning figure for demand for the years 1975-1980 from

7% per annum to 4.9% per annum. (From Southern California Edison Company forecast, 1974.)

None of the Western utility companies that were contacted foresaw any capacity problems whatsoever for the foreseeable future.

4. <u>Utility Companies Denying Navy/MC Basses During an Involuntary Curtailment (Rolling Blackout)</u>

In the course of this writer's investigation, it appeared that there may be some room for misunderstanding with regard to whether or not Navy/MC bases could count on being exempt from a rolling blackout. Although, for example, Case No. 9581 submitted by Pacific Gas and Electric Company before the California PUC on 15 October 1973 identifies "Federal activities essential for the national defense" as customers who <u>may</u> be exempted from rotating blackouts, it <u>also</u> states that such customers should be "required to establish the applicability of an exemption..." Thus, bases which cannot afford to be involved in an involuntary rolling blackout should have a written agreement to this effect with their respective utility company.

C. RECAP

Recapitulating the main points of this chapter:

1. Voluntary reduction by Navy/MC customers play an important part in the curtailment plans of most utility companies.

2. If voluntary reductions do not achieve the desired results, most companies in the Western States plan to implement rolling blackouts.

3. Bases desiring to be exempted from any rolling blackout scheme should insure that there is a clear understanding in effect between them and the utility company.

4. The reliability of power supplied by those utility companies surveyed appears to be quite adequate for the foreseeable future.

IV. ALLOCATION OF ELECTRICITY WITHIN NAVY/MC SHORE ACTIVITIES

A. DEFINITION

To allocate means "to distribute as a share or portion; assign; ration; apportion; allot." In the past, electricity has been treated by most military installations as an inexpensive, abundant, almost inexhaustible commodity. Although the managers of utilities at military installations tracked consumption and expenditures, maintained other records, and had various programs aimed at controlling wasteful use of electricity, they rarely, if ever, went to the extent of exercising allocation, or rationing, of electricity.

B. ALLOCATION/LOAD SHEDDING IN THE NAVY/MC

In the Navy/MC, the closest approach to allocation has been the development of the Load Shedding Plan. This is a contingency plan which each activity is required to have in writing, ready to be executed, in the event the normal source of supply of electricity is reduced or becomes unavailable due to a malfunction or casualty in the generation or distribution system. Just recently, associated with the Arab fuel embargo, there have been some cases in which the electricity supplied to Navy/MC bases has had to be reduced due to a scarcity of fuel to run utility company generators. Usually, Load Shedding Plans are designed with short-term, emergency situations in mind. They envision power outages or

curtailments of under 4 hours, with the worst cases not exceeding 3 days.

A true Allocation Plan, as opposed to a Load Shedding Plan, would be valid for varying periods of time. Furthermore, its implementation should not be limited to emergency situations, but it should be available to management as a tool for controlling the use of electricity, e.g. for reasons of economy - to control either total killowatt-hours (KWH's) consumed, or dollar expenditures on electricity, or <u>both</u> KWH's and dollar expenditures. A further differentiation is that Load Shedding Plans often include the use of standby or emergency generators. Since the primary objective of an Allocation Plan most likely will be the conservation of energy, such a plan would make use of few, if any, emergency generators.

C. DIRECTIVES REQUIRING A LOAD SHEDDING PLAN

There is no known requirement in Navy or Marine Corps directives for an activity to have an Allocation Plan. There are, however, at least three directives that require a Load Shedding Plan, or its equivalent. These are:

1. Chief of Naval Operations message 291819Z May 1970 /Ref. 5/. This message directed all activities to develop explicit curtailment procedures for shedding electrical loads on short notice.

2. Bureau of Yards and Docks Instruction 11300.21 of 2 May 1960, Subject: Utility Casualty Correction Plan /Ref. 3/. This instruction is usually referred to in the Disaster Recovery Plan that each Naval District Commandant is required to publish and maintain, e.g. Commandant 12th Naval District Disaster

Control Plan 1-70 [Ref. 8]. A Load Shedding Plan is (or should be) a vital component of every activity's Disaster Recovery Plan inasmuch as the latter plan prescribes the proper course of action to be taken in the event of various forms of disasters, i.e. natural disaster; Chemical, Radiological or Biological war, etc.

3. Naval Facilities Engineering Command Instruction 4100.6 of 29 March 1974, Subject: Shore Facilities Energy Conservation Program [Ref. 18]. In paragraph 3.c(2), the following statement is made:

> "Develop a detailed activity contingency plan for shortages of specific energy sources. Enclosure (6) provides guidance on contingency plan development."

D. RESULTS OF ALLOCATION/LOAD SHEDDING SURVEY

In early November 1974, a questionnaire entitled "Electrical Energy Allocation and/or Load Shedding Plan" was sent to a sampling of Navy/MC activities across the United States. The objective was to ascertain how many activities had/did not have Allocation and/or Load Shedding Plans, and to extract the best features of those that existed in order to develop a model that could be used by any activity in formulating its own plan. (See Appendix B for sample questionnaire.)

The questionnaires were sent to 103 Public Works Offices at Navy/MC bases. These included only a sampling of the small and intermediate-sized bases, but virtually all of the large bases. Since there is no known requirement in Navy/MC directives for a base to have an Allocation Plan, it is not surprising that no Allocation Plans were received in response to the questionnaire. The responses received all dealt with Load Shedding Plans. The returns on the questionnaires are summarized as follows.

DATA ON ELECTRICAL ENERGY ALLOCATION/LOAD SHEDDING PLAN QUESTIONNAIRES

Number of questionnaires sent out--------------	103
Number of questionnaires returned--------------	82
% returned = $\frac{82}{103}$ = ----------------------------	80%

Categories of responses	No.	% of total
a. Plan exists; copy sent---------	49	60
b. Plan is in preparation; will be sent at a future date.-----	8	10
c. Plan does not exist nor is it planned to write one in the near future.------------------	25	30
Total	82	100%

Figure 1

The 80% return on the questionnaires was gratifying, yet in this writer's opinion, the fact that only 60% of the bases had Allocation/Load Shedding Plans in existence, was somewhat disturbing, particularly since the quality of some of the plans was less than satisfactory. Nevertheless, there were some very well written plans. (See Appendices C, D, and E as examples.)

E. ELEMENTS OF AN EFFECTIVE LOAD SHEDDING PLAN

The following features are considered to be basic to an effective Load Shedding Plan:

1. Backed by Commanding Officer. The plan should be in the form of a Base Instruction, signed by the CO.

2. All tenant activities aboard the base should be made aware of its contents and its potential impact on them. Obtain concurrence of tenant activities in advance of execution.

3. Plan should be exercised periodically, say, twice a year, to make sure it works, that it is current, and that tenants realize how it affects them. Results of each exercise should be documented/the report distributed to all tenant activities. (See Appendix F for an example.)

4. Content:
   a. Establish conditions of reduction and describe them. One categorization scheme which is used at several activities follows:

      Phase 1: Normal operations, normal conservation practices.*

      Phase 2: Reduced demand required.

        Condition A: Reduce demand by 20%. State the amount of reduced KW's required.

---

* Note: Currently, some bases are interpreting "normal conservation practices" to mean a goal of 10% reduction below their FY-73 monthly consumption figures.

Condition B: Reduce demand by 33%. State the amount of reduced KW's required.

Condition C: Maximum reduction which allows minimal accomplishment of base mission. ________KW reduction is equal to ______% of total base demand. To be put into effect only in case of extreme emergency.

b. Identify specific facilities to which electrical power will be reduced or discontinued, and the amount of KW's involved.

5. Organization:

The established Utility Conservation organization should be utilized in putting the Load Shedding Plan into effect. The suggested members of such an organization, together with a brief outline of their functions, is included as Appendix G. It should be noted that the organization described is optimal for medium to large bases. Smaller bases may not be able to afford as many members in their conservation organization and may have to tailor its size to suit their particular capabilities.

F. THE MEASUREMENT OF ELECTRICITY USAGE

One of the largest obstacles to the management of electricity, particularly where any allocation scheme is concerned, is the inadequacy of measuring electrical utilization aboard Navy/MC bases.

Current tracking of electrical utilization aboard a base is based on the "Targets" principle as described in the Utility Target Manual, NAVFAC MO-303: [Ref. 19]

> "The Targets Program provides procedures for estimating quantities and costs for optimum utilities operations and maintenance and for comparing these with actual usage and expenditures. Thus, the Targets Program is a management tool for effective utilities control."

Although Targets are effective in establishing the "should" costs and quantities of utilities, there is a problem

in determining the "actual" costs and quantities. The "gross" amounts are not a problem, because these are identified on the utility company's bill to the station. The problem arises in attempting to determine "who" on the base used "what" amount of the given utility.

The electricity used by many of the tenants aboard a base is determined on the basis of engineering estimates, even though the stated policy advocates metering: [Ref. 20]

> "3.4.8 Metering Electricity. Metering electricity at the point of consumption is a desirable part of engineering application, management, control and accounting. Metering is desirable and applies to conservation in that it tends to increase incentive toward cost reduction by the individual user ...."

Although the desirability of metering is acknowledged, not very much guidance is given as to when metering should be provided. The algorithm that follows should provide some assistance in the decision making process.

G. A KWH METERING ALGORITHM

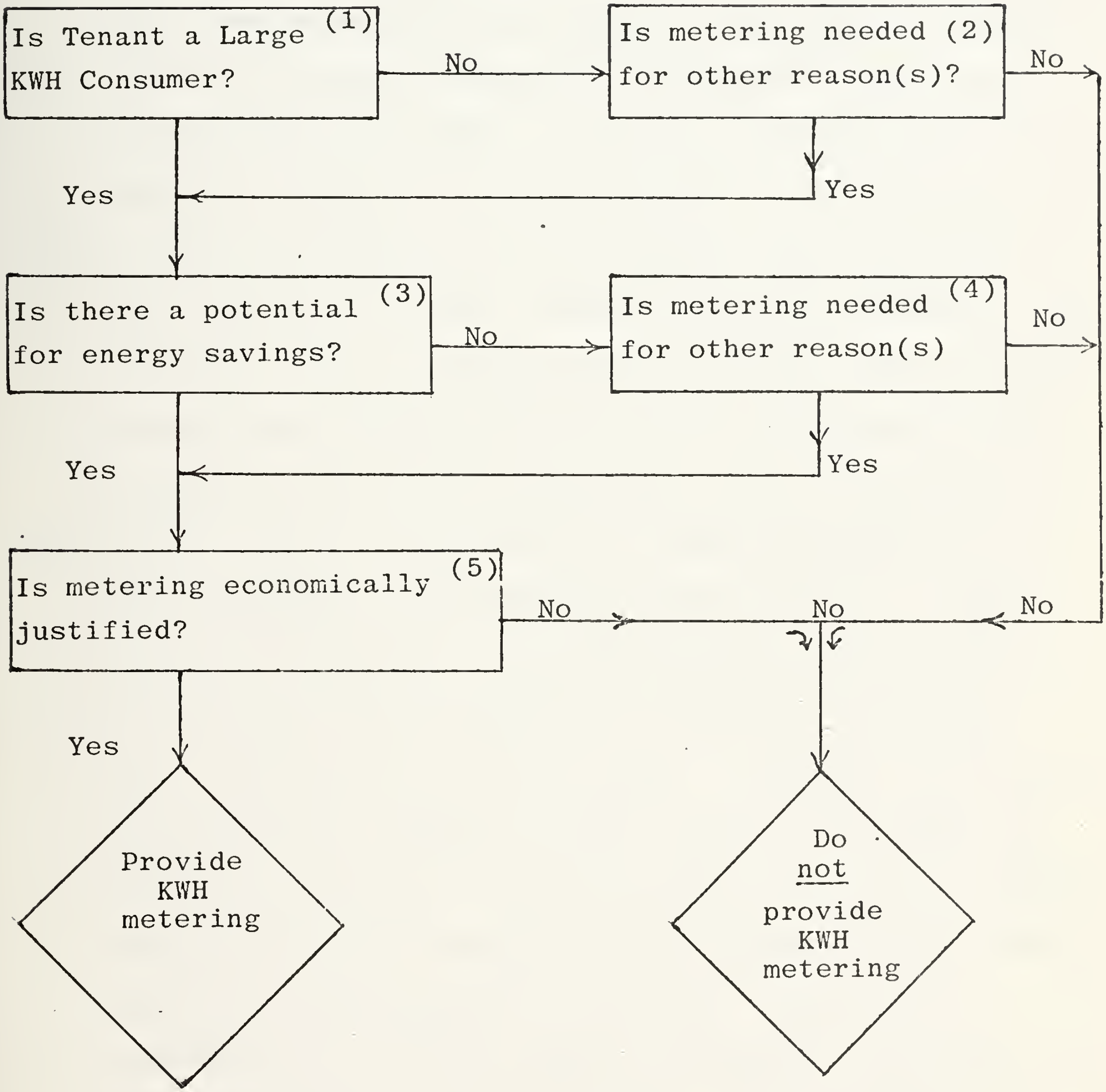


Figure 2

EXPLANATION OF KWH METERING ALGORITHM

(1) The first question that needs to be asked is whether or not the tenant is a large user of electricity. What % of total base energy does he consume? How does he rank in relation to other consumers? The answers to the last two questions will make it possible to answer the basic question: "Is he a large consumer?"

(2) Is metering needed for other reasons? It is possible that metering of a small consumer might be necessary, e.g. customers, such as Exchanges & Commissaries, who reimburse the base for the electricity they use are often metered so that the amount of reimbursement can be determined.

(3) The next question deals with the user's potential for energy savings. The maximum possible savings in KWH's should be determined. In some instances, even though the user is a large consumer of electricity, there is very little potential for savings. A computer installation is an excellent example of such a user; even though the amount of energy used is great, there is no way to reduce energy used by the computer, other than shutting it down, which is an unacceptable alternative. Metering of consumption that is not expected to change from month to month is a waste of time and money. It is adequate to determine the amount consumed through an engineering estimate or portable meters.

(4) Is metering needed for another reason? It is conceivable that there might be a large consumer with small potential

for energy savings whose load flunctuates from month to month primarily due to mission requirements, e.g. a communications installation aboard a base. It might be useful to meter such a consumer, if only to know what amount of total base consumption was attributed to that consumer.

(5) Is metering economically justified? The criteria provided in the Utilities Management Manual, NAVDOCKS P-96, states that meters will only be provided where the cost of the meter and its installation does not exceed 5% of the pro-rata annual cost of the utility to be metered. This approach is somewhat arbitrary. In this writer's opinion it would be more appropriate to justify metering on the basis of cost/benefit analysis.

H. ADDITIONAL COMMENTS WITH REGARD TO METERING

(1) Some problems may be encountered in metering a tenant whose facilities are dispersed throughout the base. Obviously, it will not be possible to use a single master meter in such a case. Most likely some combination of individual meters and engineering estimates will be required. Each individual meter will have to be justified on a cost/benefit basis.

(2) Another likely problem area is that of joint occupancy of a single building by two or more tenants. If separate metering is not physically possible, it may be necessary to install a master meter, but then to determine individual usage on the basis of engineering estimates.

(3) One possible alternative is the use of portable meters. These would normally be used where loads and consumption are relatively stable during given periods of time, or in areas of relatively small electrical usage.

(4) Every electrical distribution system experiences line (I^2R) losses and transformer losses. It is not possible to accurately measure these, but it should be possible to estimate them on the basis of length of distribution lines, type of conductor, age of system, size, number and types of transformers, etc.

(5) It is also unrealistic to expect to be able to measure every bit of electrical consumption aboard a base - the process of accounting for electrical usage must of necessity involve some degree of estimation. This is not to say, however, that uniform estimating procedures cannot be established which would allow meaningful comparisons among various consumption figures. The key to effective control, however, is the objective process of obtaining data through metering. The greater the proportion of base electrical consumption accounted for through metering, the better the chances of establishing an effective control system.

I. AN ALLOCATION PLAN

The principal difference between a Load Shedding Plan and an Allocation Plan is the element of time. Typically, a Load Shedding Plan deals with demand (Kilowatts, or KW's) while an Allocation Plan deals with consumption (Kilowatt-hours, or KWH's). An Allocation Plan also differs from a

Load Shedding Plan in that the former concerns itself with extended periods of time, and ordinarily does not include the use of base emergency generators.

It would appear on the surface that a good Load Shedding Plan is a good point of departure for the preparation of an Allocation Plan. And this is so. The areas that require additional effort and attention are the following:

a. Calculate an energy consumption (KWH) target for each tenant activity aboard the base. (See Appendix H for a sample calculation.) The aggregate of all of the tenant activities, plus any "common" facilities such as street lighting, plus transformer and line losses, should establish the "base" amount of consumption for the Navy/MC activity. This base amount would represent the amount of electricity consumed by the activity while operating at 100% effectiveness. (An alternative to a calculated target, would be to use consumption statistics for a previous period, e.g. monthly consumption during FY-73, as a "base").

b. With the availability of the above data, it should then be possible to consider various reduced levels of electrical consumption and to attempt to determine the effects of the reduced availability of electricity on the overall effectiveness of the base.

J. AN ALLOCATION MODEL

Before beginning to develop a model for solving electrical allocation problems aboard Navy/MC bases, it is necessary to define certain terms as they will be used in the model:

Tenant - An organization aboard the base that does not report to the Base CO but is dependent on the CO for certain services.

Services (provided by the Base CO's organization) - these may vary from tenant to tenant and may consist of the following: Public Works, Supply, Base Administration, Disbursing (military pay checks), Medical and Dental Services. The services provided are normally specified in the Host-Tenant Agreement between each Tenant Commander and the Base CO.

Morale-type activities (provided by the Base CO's organizations) - these activities are of the nature of a "public good" in that they are equally available to all military personnel aboard the base. Included are such things as facilities for indoor and outdoor sports, military clubs, movie theaters, snack bars and vending machines.

% of normal - in each case, "normal" would have to be defined prior to using the model. It might be convenient to define "normal" in terms of the activity that took place in a previous year which is adopted as a "base" year.

Operations - all activities of a tenant which are directly related to his mission, i.e. for an Aircraft Squadron, operations could be expressed in terms of total aircraft flight hours in a month.

Support - all activity of a tenant other than operations, e.g. for an Aircraft Squadron, Support would be expressed in terms of man-hours expended by squadron personnel in activities other than flying aircraft. Examples would be maintenance and servicing of aircraft, upkeep of personnel records, etc.

A hypothetical air base will be used to illustrate the approach to be taken in solving allocation problems by means of the utility theory of economics.

A macro view of the base will be taken and gradually be broken down into the elements which are affected by electric power allocation.

Let W = the measure of a base CO's performance,

U^1 = the utility (or "goodness") derived by Tenant #1 Commander from services provided by the base

U^2 = Same as above, but for Tenant #2 Commander

Then,

$$W = W(U^1, U^2) \qquad \text{(Equation \#1)}$$

meaning that the evaluation of a Base CO's performance is a

function of the level of satisfaction of tenant #1 and #2 Commanders.

The following should be considered with regard to the above:

1. For simplicity, it is assumed here that the base only has two tenants. In an actual situation, to allow for the opinions of all tenants and any other relevant inputs, the equation would be expanded thus:

   $W = W(U^1, U^2, \ldots U^i, \ldots U^n)$

2. The relative importance of each tenant's opinion as perceived by the Base CO can be expressed through the use of a coefficient. Thus, in a simple situation where the measure of performance is simply the sum of a CO's perception of two tenant commanders' opinions, and where one commander's opinion carries half as much weight as the other's, the expression would read as follows:

   $W = U^1 + \frac{1}{2}U^2$

Continuing the analysis, let

$$U^1 = U^1(E^1, S^1, G) \qquad \text{(Equation \#2)}$$

$$U^2 = U^2(E^2, S^2, G) \qquad \text{(Equation \#3)}$$

where E^1 = amount of electric power provided to Tenant #1

S^1 = amount of electricity used in the services provided to Tenant #1 such that $S^1 = (S^1_1, \ldots S^1_i, \ldots S^1_r)$ where S^1_i is the amount of electricity used in the i^{th} service rendered to tenant #1.

E^2, S^2 – similar to the above, but for Tenant #2.

G = amount of electricity used in the morale-type activities provided by the base such that $G = (G_1, \ldots, G_i, \ldots, G_q)$, where G_i is the amount of electricity used in providing the $i^{\underline{th}}$ morale-type activity.

As an illustration of the above, S^1_1 might represent the amount of electricity needed by the Base Supply Department to provide a certain level of service to Tenant #1. Similarly, G_1 might represent the amount of electricity required to operate the gymnasium on a prescribed schedule.

Thus, a Base CO may approach a cut back of α % of normal electrical consumption as a constrained maximization problem:

$$\text{Maximize } W = W\left[U^1(E^1, S^1, G),\ U^2(E^2, S^2, G)\right] \quad \text{(Equation \#4)}$$

subject to

$$(1-\alpha)\ \overline{B} \geq E^1 + E^2 + \sum_{i=1}^{r} S^1_i + \sum_{i=1}^{t} S^2_i + \sum_{i-1}^{s} G_i \quad \text{(Equation \#5)}$$

where $\overline{B}$ is the normal quantity of electricity consumed by the Base.

with respect to E^1, E^2, $\left[S^1 = (S^1_1, \ldots S_i, \ldots S^1_r),\right.$

$\left.(S^2_1, \ldots S^2_i, \ldots S^2_t)\right]$, and $\left[G = (G_1, \ldots, G_i, \ldots, G_s)\right]$.

For simplicity, assume that there is only one type of service provided to Tenant #1, another single service provided Tenant #2, and only one Morale-type Activity. That is,

$r = t = s = 1$

The optimality condition for the above situation is given as

$$\frac{\partial U^1}{\partial E^1} = \frac{\partial U^1}{\partial S^1}, \frac{\partial U^2}{\partial E^2}, = \frac{\partial U^2}{\partial S^2} \qquad \text{(Equation \#6)}$$

$$\frac{\partial W}{\partial E^1} \Big/ \frac{\partial W}{\partial U^2} = \frac{\partial U^2}{\partial E^2} \Big/ \frac{\partial U^1}{\partial E^1} \qquad \text{(Equation \#7)}$$

$$\frac{\partial W}{\partial U^1} \frac{\partial U^1}{\partial G} + \frac{\partial W}{\partial U^2} \frac{\partial U^2}{\partial G} = \frac{\partial W}{\partial U^1} \frac{\partial U^1}{\partial E^1} \qquad \text{(Equation \#8)}$$

which states that -

(Equation #6): The marginal utility gained by the $i^{\underline{th}}$ tenant (i = 1, 2) in consuming an incremental amount of electricity must be the same whether the electricity is provided directly (for Tenant Work - $E^{1,2}$), or indirectly (through Services performed by the Base - $S^{1,2}$).

(Equation #7): The ratio of the marginal utility gained by the Tenants by consuming the electricity (in Tenant Work) must be the reciprocal of their respective weights in the evaluation function, W. For example, if the Base CO values Tenant #1's opinion twice as much as the opinion of Tenant #2, then from the viewpoint of the Base CO, the marginal utility of the first tenant must be one half of the second tenant, which implies that more electricity should be supplied to Tenant #1 under the assumption of "Diminishing Marginal Utility."

(Equation #8): The sum of weighted marginal utility of electricity spent in Morale-type Activity must be equal to

either of the weighted marginal utilities of electricity spent directly (for Tenant Work - E^1) or indirectly (through Services performed by the Base - S^1).

By solving the above optimality consition, we can find the set of values for E^1, E^2, S^1, S^2 and G, which maximizes our objective function.

By comparing this new set of values associated with the percentage cut (α), with the original set of values, we can determine the optimal cut (or increase) to each Tenant, Service and Morale-type Activity. It is conceivable that there might be a case wherein electricity to an activity would have to be increased. In any event, to cut electricity α % uniformly will not be warranted in most circumstances as an optimal solution.

A graphical approach may also be helpful in the analysis of allocation problems. For purposes of illustration, the following assumption will be made:

1. The problem involves an hypothetical naval air base with only two tenants: Tenant #1 - Air Squadron; Tenant #2 - an Aircraft Engine Overhaul Facility.

2. The impacts of reduced levels of electrical power on tenant effectiveness are know and are plotted (Figures 11 and 13).

3. The utility of each Tenant Commander is directly proportional to his unit's effectiveness.

4. The quantities U^1, U^2 are linear.

DEFINITIONS:

E^1, S^1, G - as previously defined

$\overline{E}^1$ = Original (normal) amount of electricity provided Tenant #1

$\overline{S}^1$ = Original (normal) amount of electricity used in Services provided Tenant #1

$\overline{G}$ = Original (normal) amount of electricity used in Morale-type Activities.

β_1 β_2 β_3 - factors used to establish ratios among Tenant Work, Services and Morale-type Activities.

$$\sum_{i=1}^{3} \beta_i = 1$$

then,

$f\ (E^1)$ = the Intermediate Output produced by Tenant #1 by using E^1 (measured in terms of man-hours expended in accomplishment of Tenant #1's mission)

$\frac{f\ (E^1)}{f\ (\overline{E}^1)}$ = the Intermediate Output expressed as a % of the Original (normal) amount of electricity used by Tenant #1.

$\frac{g\ (S^1)}{g\ (\overline{S}^1)}$, $\frac{h\ (G)}{h\ (\overline{G})}$ = Similar expressions, but for Services and Morale-type Activities respectively.

Referring to the graphs, total effectiveness of a squadron is determined by reading the appropriate values, (A), (B), (C), (L), (M), (N), and utilizing them in the following operation:

$$(A \times L) + (B \times M) + (C \times N) = U^1$$

The answer obtained is a measure of the total effectiveness of the squadron and corresponds to the following:

$$\frac{f\ (E^1)}{f\ (\overline{E}^1)} \times \beta_1 + \frac{g\ (S^1)}{g\ (\overline{S}^1)} \times \beta_2 + \frac{h\ (G)}{h\ (\overline{G})}\ \beta_3 = U^1 \quad \text{(Equation \#9)}$$

which when setting $\frac{\beta_1}{f(E^1)} = \alpha_1$, $\frac{\beta_1}{g(\overline{S}^1)} = \alpha_2$ and $\frac{\beta_3}{h(\overline{G})} = \alpha_3$ becomes

$$\alpha^1 E^1 + \alpha^2 S^1 + \alpha^3 G = U^1 \qquad \text{(Equation \#10)}$$

which leads to the original assumption

$$U^1(E^1, S^1, G) = U^1 \qquad \text{(Equation \#2 repeated)}$$

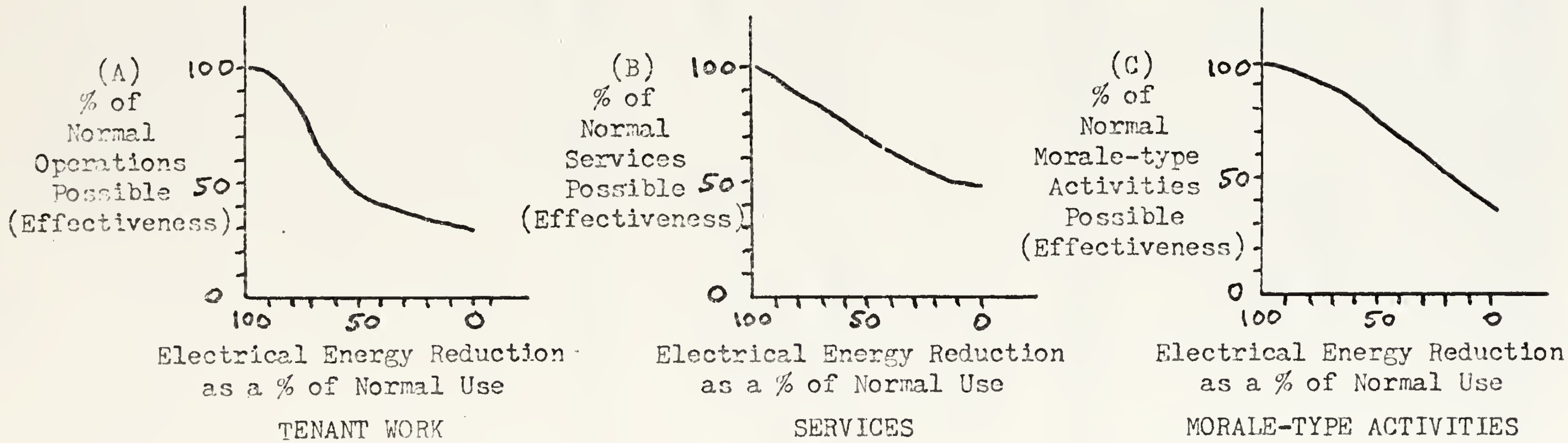
Analysis of Tenant #2's effectiveness may be approach in the same manner. Upon finding the effectiveness of the two tenants, it is then possible to evaluate the CO's performance, W, by using the function given in Equation #1.

Figure 11 depicts three curves for the effectiveness of Tenant Work, Services and Morale-type Activities under various conditions of electrical energy reduction. The chart below the curves reflects the changing weights of each of the three curves over various periods of time.

Figure 12 provides an analysis of the Air Squadron's effectiveness under various conditions of electrical cutbacks.

Figures 13 and 14 provide similar curves and analyses for an Engine Overhaul Facility.

AIR SQUADRON



UNIT'S EFFECTIVENESS IS DEPENDENT ON EACH OF THE ABOVE FACTORS AS FOLLOWS:

	Tenant's Work (L)	Services (M)	Morale-type Activities (N)
Up to 7 days	95%	4%	1%
8 - 20 days	85%	10%	5%
21 - 60 days	70%	20%	10%
Over 60 days	60%	25%	15%

ELECTRICAL ENERGY REDUTION VERSUS EFFECTIVENESS Figure 3

AIR SQUADRON EFFECTIVENESS ANALYSIS

CONDITION 1: 10% reduction in electricity for all three areas (Tenant Work, Services and Morale-type Activities) for 6 days

Tenant Work	Services	Morale-type Activities
(A) x (L)	(B) x (M)	(C) x (N)
.95 x .95 = .902	.95 x .04 = .038	.99 x .01 = .010
		Σ = .960

CONDITION 2: 30% reduction in electricity in all three areas for 21 days

.70 x .70 = .490	.80 x .20 = .160	.90 x .10 = .090
		Σ = .740

CONDITION 3: 30% reduction in Tenant Work, 20% reduction in Services, and 40% reduction in Morale-type Activities for 21 days

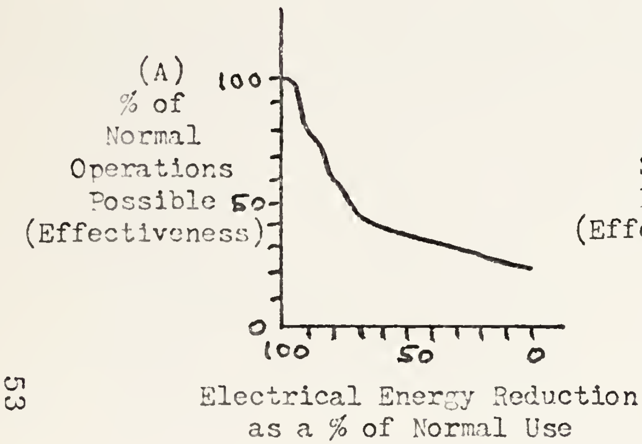
.70 x .70 = .490	.85 x .20 = .170	.85 x .10 = .085
		Σ = .745

CONDITION 4: 50% reduction in electricity in all three areas for over 60 days

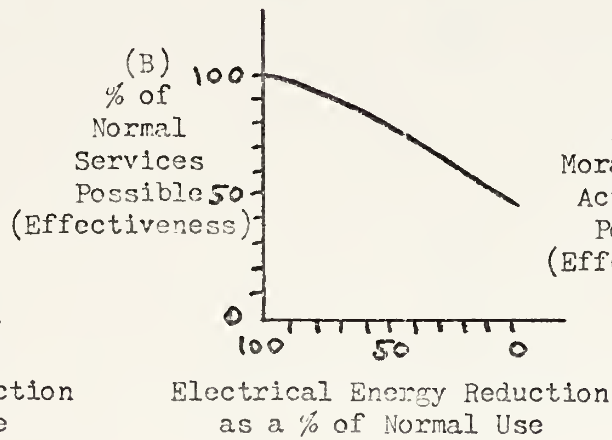
.45 x .60 = .270	.70 x .25 = .175	.75 x .15 = .112
		Σ = .557

Figure 4

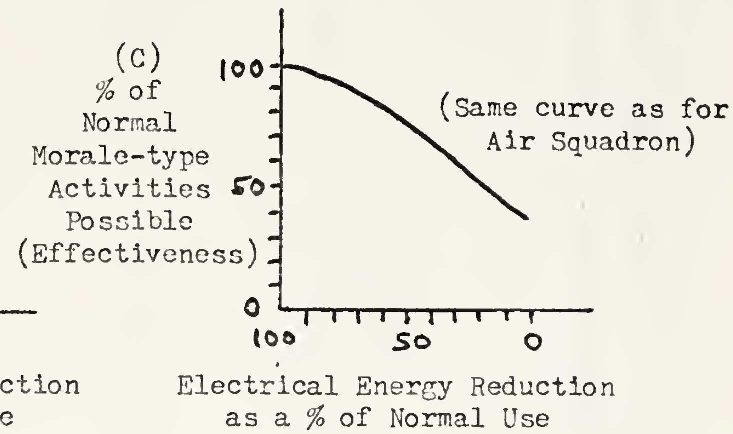
AIRCRAFT ENGINE OVERHAUL FACILITY



TENANT WORK



SERVICES



MORALE-TYPE ACTIVITIES

UNIT'S EFFECTIVENESS IS DEPENDENT ON EACH OF THE ABOVE FACTORS AS FOLLOWS:

	Tenant's Work (L)	Services (M)	Morale-type Activities (N)
Up to 7 days	90%	9%	1%
8 - 20 days	80%	15%	5%
21 - 60 days	70%	20%	10%
Over 60 days	60%	25%	15%

ELECTRICAL ENERGY REDUCTION VERSUS EFFECTIVENESS

Figure 5

AIRCRAFT ENGINE OVERHAUL FACILITY ANALYSIS

-assuming same conditions as for Air Squadron

CONDITION 1:

Tenant Work	Services	Morale-type Activities
.85 x .90 = .720	.98 x .09 = .088	.99 x .01 = .010
	Σ = .818	

CONDITION 2:

.40 x .70 = .280	.85 x .20 = .170	.90 x .10 = .090
	Σ = .540	

CONDITION 3:

.40 x .70 = .280	.90 x .20 = .180	.85 x .10 = .085
	Σ = .545	

CONDITION 4:

.35 x .60 = .210	.80 x .25 = .200	.75 x .15 = .112
	Σ = .522	

Figure 6

K. ADDITIONAL COMMENTS ON ALLOCATION

1. In the graphical analysis, the shapes of the curves will depend on the mission of each tenant;

- Some tenants may be affected more than other by a cut in electricity, resulting in a curve with a steep slope.

- Some tenants may be affected gradually until a certain point; then effectiveness might drop sharply, say, because a large electrically operated piece of equipment can no longer be operated due to a shortage of power. For example, a computer cannot be operated on 3/4 power. It must have all of the power it needs, or not operate at all.

- Other shapes of curves are also possible.

2. In any allocation planning consideration should be given to all side effects of curtailing electricity.

For example:

a. If a four day workweek is to be adopted, the following should be considered;

- most likely, it will be necessary to continue to pay most of the employees their full pay even though they work one day less.

- Other economic implications, e.g. loss of sales at the commissary, exchange, clubs, etc. should be considered.

- What are the outside factors not within the base's power to control? For example, what incoming flights are anticipated at an airbase, or incoming ships at a naval base, in the days base operations will be curtailed?

b. Although energy is saved by the base, it may not be saved by society as a whole.

- Personnel not able to use the bowling alley aboard the base might drive to the nearby town to use its bowling alley. Considering the gasoline that is expended in driving off-base, the overall result is that more energy is expended.

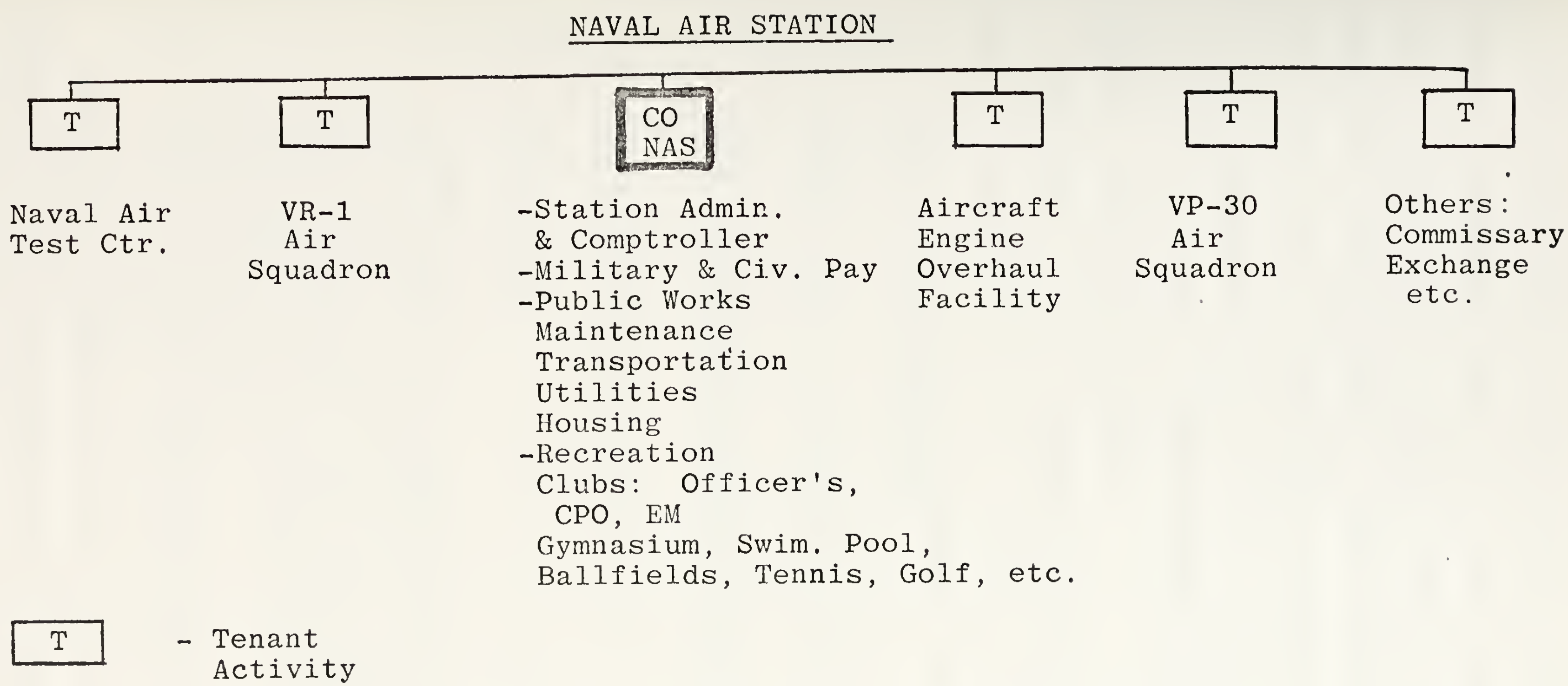
- Similarly, a civilian mail clerk who uses very little electrical energy in doing his work aboard the base may spend several hours of his newly acquired leisure time watching television in his home. In this case also, the net result to society is a loss of energy greater than before.

L. TAKING ORGANIZATIONAL REALITIES INTO ACCOUNT WHEN DEVELOPING A "KWH BUDGET"

At this point it is necessary to clarify the status of Commanding Officers with regard to tenant activities. It might be thought that the Commanding Officer of a base has virtualy autonomy over the activities of all personnel and organizations aboard his base. Although the CO is usually the senior ranking officer, and he exerts considerable influence over the general conduct of individuals and organizations aboard the base, the fact remains that many organizations aboard a base report to some authority other than the Commanding Officer, e.g. a Major Claimant, Unified or Specified Command, Bureau, etc. The Commanding Officer of the base often has little or nothing to say about the operations of tenant organizations.

Generally speaking, the Commanding Officer's role with respect to tenant activities can be likened to that of a host or landloard. He is the "owner" of all of the land and facilities, including the buildings and utilities systems. He assigns land and buildings to tenants according to their needs.

The following chart describes the relationship between the Commanding Officer and the Tenant Activities at a hypothetical base:



ORGANIZATIONAL RELATIONSHIPS AT A HYPOTHETICAL NAVAL AIR STATION

Figure 7

The point that is being made is that the relationship between the base CO and the tenants comes closer to being a relationship among co-equals, rather than a superior-subordinate relationship. Where any kind of an electrical allocation plan is concerned, the CO of the base must depend on the Commanders of the tenant activity to tell him to what extent their mission effectiveness would be affected by reduced electricity levels.

Therefore, it is suggested that electrical allocation plans be approached in the following manner:

1. The CO of the base determines the overall goal of the base for KWH reduction.

2. Through the use of the Allocation Model, several alternative plans are developed for achieving the overall goal.

3. Tenant Commanders are given an opportunity to comment on each of the alternatives, particularly as to the effect each will have on the accomplishment of their mission.

4. Tenant Commanders propose their own plans, or elect the alternative which they favor.

5. The CO holds a meeting with Tenant CO's in which a plan is adopted.

6. A "KWH Budget" is developed indicating the amount of electricity to be used by each tenant in "Tenant Work," the amount to be used by the Base in providing "Services," and amount to be used by the Base in providing "Morale-type Activities." The "KWH Budget" is supported by a detailed Plan of Operation which specifies such things as reduced hours of operations of facilities, air conditioning, etc.

7. Base activities and each tenant would then be responsible to stay within the agreed-upon KWH Budget.

Presently, bases are under orders from the Chief of Naval Operations to reduce energy usage in FY-75 to 85% of the FY-73 "base year" usage. The directive was actually

passed through the chain of command of each tenant, so the Base Commander's energy reduction objectives essentially coincide with those of his tenants. Because of this, a Base Commander will normally find his tenant commanders to be cooperative in any energy conservation efforts, at least up to a reduction of 15%.

The development of an energy conservation organization such as the one described in Appendix G, is essential if energy conservation is to be successful. The techniques involved in the creation of such an organization are beyond the scope of this thesis. However, there are numerous references currently available which deal with organizational change and organizational development [Refs. 39, 40, 41].

M. MONITORING PROGRESS, AND INCENTIVES THAT CAN BE OFFERED FOR STAYING WITHIN THE KWH BUDGET

The Public Works Officer, under his responsibilities as Utilities Conservation Officer (UCO), is responsible for monitoring the progress of each tenant activity in meeting its KWH budget. He will provide tenants with all of the technical assistance and advice available in the Public Works Department, particularly where it appears that the tenant may be having trouble meeting his KWH allotment.

The Public Works Officer makes a report on the Status of the KWH budget at the CO's conference on a monthly basis. The CO and the tenants can observe their progress toward meeting their individual goals. The reviews during the CO's conferences often provide sufficient incentive to tenant

Commanders to keep pressing for effective conservation measures. Also, some form of public recognition of activities that meet or exceed their KWH budgets may be instituted by the CO.

Possibly one of the most unpopular actions that can be taken is the discontinuance of electrical service. However, this is an alternative that can be considered in the enforcement of an allocation program. A contingency plan developed by one of the large utility companies calls for turning off the power for the length of time necessary to "save" the amount by which the allocation was exceeded by the customer.

Another possible sanction would be the imposition of a severe monetary penalty. Effectively, the wasteful tenants would be made to pay more than their "normal" share of the station's electric bill, thereby resulting in lesser charges for conservation-minded tenants.

Rather than be subjected to an unscheduled outage, tenant activities who are faced with large electrical energy reductions due to allocations might consider reducing working hours or days of work. This approach is suggested in enclosure (6) of NAVFACINST 4100.6 [Ref. 18]. Also, the Assistant Secretary of Defense in his memorandum to the Secretaries of the Military Departments, et al, states: [Ref. 10]

"B. Reduced Work Schedules.

"You are asked to initiate a review of work schedules throughout your organization. Managements should examine mission and workload requirements to identify any areas in which single work shifts can be utilized in lieu of multi-shift operations. Overtime and week-end work will be limited to critical mission essential operations.

"Consideration should be given to curtailing operations during holiday periods where liberal leave policies normally are in effect, and where significant energy conservation will result. Installations should not normally be closed for the holidays, but measures short of closure can be effective in conserving energy in some situations through use of liberal leave policy and consolidation or reduction of operations...."

On several occasions in the past few years several bases, such as NAS Moffet Field, California and the Naval Weapons Station, Concord, California have gone into a period of "reduced operations" during the Christmas/New Year holidays, with at least a partial objective being the conservation of utilities.

During the 1974 Christmas holidays the Naval Weapons Station, Concord, published this notice: /Ref. 23/

"HOLIDAY CLOSURE SCHEDULE. The Naval Weapons Station, Concord, Ca., will reduce operations during the Christmas Holidays from 1600, 20 Dec. 74 thru 5 Jan. 75. Emergency numbers to contact are ..."

Thus it can be seen that in some cases reduced operations can be a means of meeting an energy reduction goal.

N. SOME OTHER THOUGHTS ON ELECTRICAL ALLOCATIONS

There are many ways, short of denying an activity electric power, that electrical consumption can be reduced. There are numerous military and civilian publications offering advice on the subject. In addition to prudent usage practices by individuals, there are often physical improvements that can be made to the electrical system that can result in more efficient use of electricity. Whatever measures are decided upon, they should be in conformance with the Chief of Naval Operations' goal... "to achieve maximum energy conservation with minimum mission support capability degradation." /Ref. 6/

V. TOWARDS MORE EFFICIENT ENERGY MANAGEMENT: CENTRAL PROCESS CONTROLLERS AND OTHER DEVICES

A. ADVANTAGES OF AUTOMATED SYSTEMS

Automating the controls of power consuming systems in such a way as to make them less dependent on repetitive human decision and action can result in conservation of energy. For instance, before photoelecric cells gained wide acceptance, street lights had to be turned on and off by someone. If the individual was an hour late in turning them off, that was an hour's wasted electricity. Now, with almost universal use of photoelectric cells on street lights, not only is there a substantial savings in energy, but also in manpower.

Another device that is being used increasingly is the automatic timer. Lights, fans, heaters, air conditioners, boilers and other types of equipment are being turned on and off automatically by relatively inexpensive timing devices. Most of the devices have an over-ride feature that can be used on those infrequent occasions when there is a need to use the equipment during "normally off" hours. Also, resetting the operating hours is fairly simple on most timers.

B. NON-COMPUTERIZED AND COMPUTERIZED PROCESS CONTROLLERS

Another way of achieving automated control is through the use of process controllers. These are solid-state electronic devices which make it possible to control numerous pieces of equipment from one remote location. Hookup to each

piece of equipment is through owned or leased telephone lines. Non-computerized process controllers are available which perform the following functions:

- provide on-off controls which are activated manually, or automatically at preset times.

- monitor and record information about equipment, buildings and/or systems.

- provide alarm systems with adjustable limits, e.g. monitor water temperatures in/out of a chiller in a large air conditioning system.

- combinations of the above, e.g. monitor in/out water temperaturees of a chiller (driven by an electric motor). When the difference in temperatures, Δt, reaches a preset low limit, say 4^o, system can be programmed to shut the chiller off (because it is inefficient to operate the chiller when Δt is 4^o or less).

- capability of being reprogrammed.

A non-computerized system which would accomplish the functions described above, would consist of the following components:

a. Console - a teletype - like unit with a lighted display window where status and measurement units (such as degrees, kilowatts, pressures, etc.) appear in easy-to-read format.

b. Central Processing Unit (CPU) - a solid-state electronic component which gathers data and receives requests for information. The Central Processor memory can store such values as the upper and lower limits for various components of the system. The Central Processor can be used to initiate actions based on preprogramming, and can be programmed to react to certain outside occurances. This is the "heart" of any system, whether computerized or not.

c. Printer - records interactions between the operator, console, CPU and the various system components; through the CPU, the printer can be programmed to print data at set intervals when performing an equipment or systems check. Another function is to print out message warnings reporting malfunctions, identifying the location of the trouble and, if some cases, the possible causes and corrective measures that can be taken.

A more versatile system can be obtained through the addition of other components, such as:

a. Computer - a digital process mini-computer which:
   1) accepts continuous data inputs as picked up by sensors from the various pieces of operating equipment and systems,
   2) analyzes these data in accordance with pre-established programs, and
   3) feeds control commands back to the components in the electrical and/or mechanical systems.

b. Software routines (called "optimizing packages" by one manufacturer)
   - a program containing least-cost equations based on historical data, constantly updated by internally monitored variables which solve themselves without human intervention. It then automatically adjusts equipment start-stop schedules or system outputs for minimum cost operation.
   - a program which integrates past and predicted electrical demand for all electricity-using facilities in the system. Then, as predicted power peaks approach, the computer reschedules utilization, sometimes shutting down low priority systems, until the threatened overload is past. This distributes power consumption more evenly throughout the day, eliminating rate penalties which are applied to uneven demands.
   - a program which integrates variations in temperature and humidity for both outside and inside air, then adjusts damper settings accordingly. The result is the best combination of outside and return air at a minimum load on the heating/cooling system.
   - programs which adjust the schedules of individual chillers to minimize total cooling costs and adjust heating plant start-up time each day to minimize total energy consumption.
   - cost analysis: on demand, the system can provide such performance data as accumulated run time, kilowatt hours, kilowatt demand, tons of refrigeration, BTU hours, etc. for any system. These energy consumption values can be expressed by the computer in dollars and cents. This kind of information is useful for allocating costs within the system and for analyzing performance of individual facilities.

c. Display Unit - this is basically a slide projector enclosed in a case.
   - The slides show schematics of the various electrical/mechanical systems, indicating the system configuration and the location of the sensors in the system. The

Display Unit serves as an aid to operating and maintenance personnel in understanding a particular malfunction and its relation to the component system.

d. Cathode Ray Tube (CRT) visual display
- A TV-like display that can be used in conjunction with the graphics module and printer. For instance, if the operator wants to examine the past performance of a particular piece of equipment, by entering the appropriate commands on the console and depressing the display button, complete data about every point in that chiller plant are instantly displayed on the CRT screen.

The hardware concept behind the design of most process controllers is modularity. Thus, it is possible to start with a relatively simple system and expand as needed without replacement or elimination of any previously bought hardware. For example, the basic Honeywell Delta 2000 system provides start/stop control and status alarm monitoring for up to 3900 operating points. This capacity can be expanded tenfold with the addition of simple plug-in modules /Ref. 13/.

The mini-computer is another optional modular component of a process control system. A report by Booz-Allen and Hamilton, Incorporated has the following discussion concerning computers: /Ref. 2/

"One basic decision to be made in planning a control system is whether or not to install a computer in a center. The computer, by far the most expensive item in a control center, requires the most sophistication to manage. Whether a computer installation is a sound capital investment will depend upon what the center is designed to do and how the building engineer uses the center. An under-utilized computer, due to poor design or distrust on the part of the operators, will not pay its own way."

In its own promotional literature, Honeywell states: /Ref. 13/

"Even though a computer is no longer a must ... neither is it a luxury when your need for greater computational skills or more responsive control is sufficient to justify your investment in a computer ...."

One important area not given sufficient emphasis in the existing literature is the area of controls on individual pieces of equipment. Effectively, controls have to be electrically operated and compatible with the process control equipment that is being installed. For example, butterfly-type, manual valves have to be fitted with electric motor-run adaptors. Where reading of values such as temperatures, pressures, kilowatts, and kilowatt-hours are concerned, yet other types of adaptors are required. (In the case of energy-use monitoring, watt-transducers are needed.) Thus, in a break-down of the cost of a system recently installed in the 20 year old industrial complex operated by General Dynamics for the Navy, it can be seen that the modification of existing equipment has the highest cost: /Ref. 14/

Cost of equipment modernization	$152,000
Delta 2000 Phase I	86,824
Delta 2000 Phase II	59,630
Cost of Modernization and Centralization	$298,454

In addition to the expense involved, depending on the type and condition of existing equipment, technical problems may be encountered in attempting to tie it into the control center.

Despite the apparent high costs involved, a number of reports indicate that the installation of such systems has been justified. Several examples follow: /Ref. 2/

1. Pomona Division of General Dynamics

Description of facility: Eight major one-story buildings containing 1,500,000 square feet of floor space, employing 8,000 people.

Age of facility at time of central process controller installation: About 20 years.

Year Central Process Controller installed: 1969

Type controller: Honeywell Delta 2000

Systems controlled:

Phase I - chillers, compressors, emergency generators, fire pumps and reservoir, steam boilers, 20 hot water boilers, and miscellaneous plant equipment.

Phase II - 46 rooftop fan houses, 31 fan coil units, 11 cold storage areas, and various plant equipment.

Estimated Saving:

Operating staff reduced 55%.

Energy Savings - not quantified, but considered to be significant.

Estimated payback period - 2.6 years, based only on labor savings (energy savings not included).

2. Fort Ord Army Base, California.

Description of facility: Large Army base with widely dispersed facilities.

Age of facility at time of central process controller installation: Buildings of various ages, some over 20 years old.

Year central process controller installed: 1962

Type controller: IBM Simplex

Systems controlled: Heating plants for 1500 buildings.

Cost to install control system: $49,000

Estimated savings:

Operations - $80,000 per month

Energy savings - information not available.

3. Marine Corps Base, Camp Pendleton, California

Description of facility: Large Marine Corps base with widely dispersed facilities.

Age of facility at time of central process controller installation: Buildings of various ages, some over 20 years old.

Year central process controller installed: 1973

Type controller: Honeywell Delta 2000

Systems controlled: Heating plants for 135 buildings.

Cost to install control system: System installed on a 5 year lease-purchase agreement: after 5 years of lease payments, system will belong to Marines. Total cost approximately $250,000 (exclusive of separate maintenance contract with Honeywell).

Estimated savings:

Fuel oil consumption cut approximately in half (reduced by 48.9%) in FY-74 as compared with FY-73. Although some of the savings can be attributed to more austere heating practices, the central process control system also played a great part in achieving the savings.

Payback period: estimated as 1 year by Honeywell

4. World Bank Building, Washington, D.C.

Description of facility: 13 - stories, 445,000 square feet.

Age of facility at time of central process controller installation: Unknown, except that the facility was not new when the controller was installed.

Year central process controller installed: 1966

Type controller: Robertshaw Controls with 12,000-word Westinghouse Prodak-50 digital computer.

Cost to install: Est.: $50,000, Actual: $71,600

Savings:

On energy (electricity and fuel oil) costs- Est.: $20,000/yr.; Actual: $45,100 per year for first 3 years of operations

Personnel costs - not available

Payback period: Est.: 27 months, Actual: 25 months

Systems controlled:

Fire management: If a fire is detected, a prerecorded message is played in both the security station and the maintenance headquarters, giving position of the fire and instructions on what to do.

Environmental management includes: Turning off lights at predetermined intervals; calculating load for chillers and assigning the loads so that the chillers are running at their highest efficiencies; printing a daily log indicating costs and amounts of utilities used; starting heating/cooling equipment at the last possible moment to reach a set level at occupancy time; selecting makeup air or return air and adjusting dampers to get the maximum cooling or heating from air sources; performing efficiency calculations on certain large pieces of equipment at set intervals.

There are also central process control systems in use today which, in addition to performing functions such as those described above, are designed to do the following:

- Provide security and fire protection
- Shed secondary electrical loads so that a set electrical demand is not exceeded.
- Provide profiles and forecasts of electrical demands for a building, unit of equipment, or system.

C. NAVY/MC USE OF CENTRAL PROCESS CONTROL SYSTEMS

The Navy and Marine Corps have been slow to install central process control systems. There are several reasons for this, including the following:

1. The high initial expense involved. Low energy costs as recently as two years ago, made these systems relatively expensive. Today's higher energy costs make these systems more economically attractive, especially when analyzed on the basis of life-cycle costing.

2. Skepticism among Navy/MC utilities managers and planners about the system's ability to perform all of its design functions. There is a serious lack of consistent performance data on existing systems. Also, it has been found that an installation that works perfectly in one case, may not work as well in another. The installation design may make the difference between a successful system in one location and a failure in another.

3. Breaking-in time - It takes at least one full year to run through all the seasons to ensure that both the sensors, the individual equipment controls and the control center are performing adequately.

4. Extent of training required for operator personnel - though the centers themselves are complicated (just as a modern automobile is complicated), the skill level required to operate a system is not high. However, a problem that might evolve is one of motivation- the building (or facility) engineer, either out of boredom or out of fear of losing his job, may be disinclined to use the system to its full potential.

On the positive side, as stated before, the increasing scarecity and higher prices of energy resources, make a central process control system attractive. Also, the great dispersion of facilities aboard Navy/MC bases (a condition not shared by very many enterprises in the commercial sector), requires a sizeable number of operations and maintenance personnel. As shown in the preceeding examples, there can be a substantial reduction in the requirement for operations and maintenance personnel through use of a central control system.

It is recommended that detailed studies be initiated for the installation of rudimentary process control system at several large bases. As each of these rudimentary systems is installed, de-bugged, and is made to show that expansion is justified, it should be expanded. Preliminary indications are that, on large bases, rudimentary non-computerized systems

will pay for themselves within three years or less, assuming adequate design and de-bugging. As a data base is developed on installation costs, labor savings and energy reduction, it is conceivable that such systems might be justified for medium-sized, or even small bases. The potential savings to the Navy/MC may be enormous.

Finally, it is important that a control system insure reliable service. To this end, it is highly recommended that the bases give maintenance personnel top quality training, or preferably, let a maintenance contract with the control system manufacturer.

VI. SUMMARY AND CONCLUSIONS

A. SUMMARY

The first two chapters provided the setting for the focal point of this thesis - electrical energy allocations at Navy/MC Shore Activities. The setting that was described was one of rising demand for different forms of energy, a rapidly exhausting supply of the most popular forms of energy, and consequent rapid increases in cost for these energy forms. It was shown that the cost of electricity is directly related to the cost of the energy source used to generate the electricity. Utility companies dependent on oil raised their prices as a result of oil price increases. These oil price increases were often passed on to the customers as "Fuel Cost Adjustments."

The demand for electricity is projected to continue to rise. It is estimated that total U.S. energy needs in the year 2000 will be about three times that of 1970, with the production of electricity consuming about 43% of that total.

It was shown that electrical costs at several Navy/MC bases have increased dramatically in the past two years, and it was predicted that costs would continue to rise causing a significant impact on the bases' operations and maintenance budgets.

Since the majority of Navy/MC bases depend on public utility companies for electricity, the conditions of service

were investigated, with particular emphasis on steps that would be taken in the event of a fuel shortage or other emergency. In effect, this was an investigation of utillity companies' allocation procedures.

The results of the investigation, presented in Chapter III, indicate that the procedures of all companies queried were essentially as follows:

1. Request customers to reduce electrical usage during the emergency period (Voluntary Plan).

2. If voluntary reduction did not achieve the desired results, selective tripping of feeders, or a "Rolling Blackout" concept, would be undertaken (Involuntary Plan).

Other aspects of Navy/MC and public utility company relationships were discussed in Chapter II including adequacy of future generating capacities, probabilities of large scale uncontrolled blackouts, and the possible vulnerability of Navy/MC bases in rolling blackout situations.

Chapter IV dealt with the allocation of electricity within Navy/MC bases. Although the master meter for a base identifies the total electricity used, the identification of "who uses how much" aboard the base cannot be adequately identified because of internal metering deficiencies. This problem must be corrected before any allocation scheme can be implemented.

At some bases, a rough allocation plan exists in the form of a Load Shedding Plan. Such a plan is intended for emergencies of short duration. However, a Load Shedding Plan is a good point of departure for the development of the more

sophisticated Allocation Plan whose intent would be primarily to serve as a management tool for the control of electrical utilization over varying periods of time. An Allocation Plan would provide the blueprint that management could follow to achieve a particular energy utilization or conservation goal.

Also in Chapter IV, a mathematical approach was taken to measure the effect of reduced electricity on an activity's effectiveness. A number of assumptions were made in the hypothetical example given. Any "real life" problem could be approached in a similar manner.

The allocation problem was then approached in general, theoretical terms, and again a number of assumptions were made. A rudimentary model was given for use in developing Allocation Plans for individual bases or for serveral bases that are similar to one another.

Chapter IV concluded with a discussion of the basic organizational structure that is required on a base to effect an energy allocation program. Essentially, a base that has an effective utilities conservation organization should be able to implement an allocation program effectively.

The basis for the discussion of allocation is a desire by the Navy/MC to find a way to control energy utilization. Another means of providing the desired control capability is through a central process control system. Chapter V provides a discussion of such systems. The point is made that, although such systems have been relatively expensive in the

past, they might bear closer consideration now that the potential energy dollar savings have increased due to the rapidly increasing costs of energy.

B. CONCLUSIONS

At the current rate of utilization, the world's most used energy sources, fossil fuels (primarily oil and gas), will be depleted some time between the years 2000 and 2075. The U.S. supply is expected to be depleted even sooner. Dependency on electricity will continue to increase. Unless cheaper sources of energy are found for the production of electricity, its cost will continue to rise.

Dependency of Navy/MC bases on public utility companies for electricity will continue. Such continued dependency is sound, at least insofar as the bases and utility companies that were surveyed on the West Coast are concerned. The one possible area of difficulty is that a base may be affected if a rolling blackout is implemented. To forestall such an occurrence, individual bases should be sure that they are not included in any rolling blackout plan of the utility company serving them.

With regard to internal management of electricity aboard a base, the following conclusions are reached:

1. Metering is required for proper control. As a minimum, it should be possible to determine the amounts of electricity used by each tenant command aboard the base.

2. Then, it should be possible to develop a "KWH-Budget" based on past electrical utilization, "targets," and constraints such as reduced levels of consumption that may be requested by the local utility company due to fuel shortages.

3. An analytic approach such as described in Chapter IV can be used when less than optimal amounts of electricity are anticipated to be available. Under such conditions, the effectiveness of the base can be expected to be the trade-off for the reductions in electricity. The analytic model can be applied to various situations of reduced electrical use, giving the decision maker (CO of the base) a choice as to the combination of reduced operations that he finds optimal.

4. Central process control centers show promise in several areas relative to energy use management:

   a. They provide a capability for centrally controlling basic ON-OFF functions. Combined with the programmable timing feature, it is possible to insure that major equipment and other energy consuming systems operate only when desired. For instance, central heating or air conditioning in several buildings can be programmed to be turned off during nights and weekends. If necessary, the programmed hours/days can be changed within minutes.

   b. Central process controllers can be used to record the total load (KW's) on the base, and can be programmed to drop loads (load shedding) so that a predetermined peak load is not exceeded, thereby avoiding the incurrence of expensive penalty charges.

   c. They can be used to record total consumption (KWH's), and trends in consumption. If it is sensed that the trend will cause the total "KWH Budget" for the period to be exceeded, load shedding will take place as necessary to stay within the budget, in accordance with preprogrammed instructions.

   d. During periods of reduced energy availability, alternate plans to use the scarce energy resources can be evaluated using a mathematical approach such as the one described in paragraph 3 above and in Chapter IV. The plan that is selected can be implemented in a matter of minutes by programming the appropriate operations into the central process controller. Thus, for example, if it is determined that an activity will go to a four-day workweek versus a five-day workweek, and that as a result, its central air conditioner can be shut down for an additional day, such a change can easily be made by modifying the controlling program at the central process controller. The foregoing sounds

rather simple in itself, but if such a change were necessary in 50 or 100 different energy consuming systems, (e.g. heating, air conditioning, large fans, etc,), the benefits of a central processing system can readily be appreciated.

There are many ways in which energy can be used more efficiently. This thesis has just explored a few of these. Of the items discussed, central process controllers appear to have the greatest potential for energy savings, although the savings in energy may entail high initial dollar expenditures. The Naval Facilities Engineering Command has engaged a private consulting firm to develop a manual to be used by Navy/MC bases in evaluating the bids of central process controller manufacturers. With the completion of the manual, and with the ever-growing data-base on existing military and commercial installations, better evaluations of the cost/benefits of proposed systems should be possible.

There are many related areas for possible study, including the following:

The use of different approaches to the allocation problem, including such techniques as multivariate analysis and the transportation model. It may be convenient, or even necessary, to use a computer in some of the more complex approaches.

Another area bearing further study is the identification and quantification of the benefits of metering.

Still another area of study would be the use of controls that are less versatile and less costly than process controllers, e. g. timers, thermostats, load peeking controls and air conditioner damper controls.

Finally, the theory on electrical allocation that was presented in Chapter IV of this thesis remains to be tried on a Navy or Marine Corps base.

NAVAL WEAPONS STATION, SEAL BEACH, CALIFORNIA — SAN DIEGO GAS AND ELECTRIC CO.

Station — Utility Company

PERIOD	KWH's	Incr. (+) Decr. (-)	Cost	Incr. (+) Decr. (-)	Rate Cost/KWH	Incr. (+) Decr. (-)
June 1972	838,696	0%	$ 10,209	0%	.0122	0%
June 1973	1,250,000	49% (+)	19,161	88% (+)	.0153	25% (+)
June 1974	1,249,200	49% (+)	30,649	200% (+)	.0245	100% (+)
FY 72	10,507,744	0%	120,662	0%	.0115	0%
FY 73	13,069,544	24% (+)	179,159	49% (+)	.0137	19% (+)
FY 74	12,369,040	18% (+)	298,984	148% (+)	.0242	110% (+)

Total Operations and Maintenance Expenditures

	O&MN Cost	Incr. (+) Decr. (-)	Yearly Elect. Costs as a % of Total Expenditures
FY 72	$4,603,442	0%	3%
FY 73	3,146,667	32% (-)	6%
FY 74	5,107,593	11% (+)	6%

APPENDIX A: SAMPLE NAVY/MC CONSUMPTION AND COSTS OF ELECTRICITY

MARINE CORPS AIR STATION, EL TORO, CALIFORNIA
Station

SO. CALIFORNIA EDISON CO.
Utility Company

PERIOD	KWH's	Incr. (+) Decr. (-)	Cost	Incr. (+) Decr. (-)	Rate Cost/KWH	Incr. (+) Decr. (-)
June 1972	5,133,761	0%	$ 52,458	0%	.0102	0%
June 1973	4,162,800	19% (-)	53,208	1% (+)	.0128	25% (+)
June 1974	3,742,000	27% (-)	90,873	73% (+)	.0243	138% (+)
FY 72	74,505,291	0%	649,850	0%	.0087	0%
FY 73	51,067,200	13% (-)	563,145	13% (-)	.0110	26% (+)
FY 74	48,037,200	36% (-)	820,563	26% (+)	.0171	97% (+)

Total Operations and Maintenance Expenditures

	O&MN Cost	Incr. (+) Decr. (-)	Yearly Elect. Costs as a % of Total Expenditures
FY 72	$7,736,106	0%	8.4%
FY 73	7,595,120	2% (-)	7.4%
FY 74	7,543,263	2% (-)	10.9%

NAVAL SECURITY GROUP, SKAGGS ISLAND, CALIFORNIA — PACIFIC GAS & ELECTRIC CO.

Station — Utility Company

PERIOD	KWH's	Incr. (+) Decr. (-)	Cost	Incr. (+) Decr. (-)	Rate Cost/KWH	Incr. (+) Decr. (-)
June 1972	716,400	0%	$ 6,997	0%	.0098	0%
June 1973	802,800	12% (+)	8,850	26% (+)	.0110	12% (+)
June 1974	689,400	4% (-)	9,941	42% (+)	.0144	47% (+)
FY 72	8,159,400	0%	79,882	0%	.0098	0%
FY 73	8,476,536	4% (+)	85,632	7% (+)	.0101	3% (+)
FY 74	7,311,936	10% (-)	93,187	17% (+)	.0127	30% (+)

Total Operations and Maintenance Expenditures

	O&MN Cost	Incr. (+) Decr. (-)	Yearly Elect. Costs as a % of Total Expenditures
FY 72	$346,234	0%	21.9%
FY 73	352,434	2% (+)	24.3%
FY 74	380,407	10% (+)	24.5%

MARINE CORPS AIR STATION, YUMA, ARIZONA — Station

ARIZONA PUBLIC SERVICE CO. — Utility Company

PERIOD	KWH's	Incr. (+) Decr. (-)	Cost	Incr. (+) Decr. (-)	Rate Cost/KWH	Incr. (+) Decr. (-)
June 1972	4,510,408	0%	$ 55,349	0%	.0123	0%
June 1973	4,641,600	3% (+)	62,811	13% (+)	.0135	10% (+)
June 1974	4,148,400	8% (-)	69,297	25% (+)	.0167	36% (+)
FY 72	41,205,468	0%	474,950	0%	,0115	0%
FY 73	41,468,000	1% (+)	514,700	8% (+)	.0124	8% (+)
FY 74	39,413,600	4% (-)	581,284	22% (+)	.0147	28% (+)

Total Operations and Maintenance Expenditures

	O&MN Cost	Incr. (+) Decr. (-)	Yearly Elect. Costs as a % of Total Expenditures
FY 72	$2,593,682*	0%	18%
FY 73	2,470,729*	5% (-)	21%
FY 74	3,031,685*	17% (+)	19%

* Real Property (Class II) Maintenance Costs only

NAVAL AIR STATION, WHIDBEY ISLAND, WASHINGTON

Station

PUGET SOUND POWER & LIGHT CO.

Utility Company

PERIOD	KWH's	Incr. (+) Decr. (-)	Cost	Incr. (+) Decr. (-)	Rate Cost/KWH	Incr. (+) Decr. (-)
June 1972	5,102,104	0%	$ 56,052	0%	.0110	0%
June 1973	6,382,530	25% (+)	59,825	7% (+)	.0095	14% (-)
June 1974	5,579,150	9% (+)	53,431	5% (-)	.0096	13% (-)
FY 72	58,394,906	0%	654,205	0%	.0112	0%
FY 73	67,200,422	15% (+)	630,397	5% (-)	.0094	16% (-)
FY 74	83,105,317	42% (+)	647,315	1% (-)	.0078	30% (-)

Total Operations and Maintenance Expenditures

	O&MN Cost	Incr. (+) Decr. (-)	Yearly Elect. Costs as a % of Total Expenditures
FY 72	$5,162,719	0%	13%
FY 73	5,776,488	12% (+)	11%
FY 74	6,213,877	20% (+)	10%

QUESTIONNAIRE SENT TO NAVY/MC BASES

NAVAL POSTGRADUATE SCHOOL
Monterey, California

From: LCDR Alexander Shalar, CEC, USN, SMC-2997, Naval Postgraduate School, Monterey, California 93940
To:

Subj: Electrical Energy Allocation and/or Load Shedding Plan

Encl: (1) Reply Form

1. A study is being conducted by the undersigned in cooperation with the Civil Engineer Laboratory, Port Hueneme and the Naval Postgraduate School. The objective of the study is as follows:

a. By random sampling, determine how many activities have/do not have Electrical Energy Allocation and/or Load Shedding Plans.

b. Evaluate those plans that exist with a view toward selecting the best features of each plan.

c. Develop a model that may be used by any activity in coming up with its own internal plan, or improving its existing plan.

2. It is requested that you complete and return enclosure (1) within 10 days of receipt of this letter. Negative replies are solicited solely for the purpose of determining the extent to which these types of plans exist/do not exist at Naval activities. Activities reporting that they do not have plans will not be identified in the final report, nor will any action be taken which will be detrimental to the activity.

3. Your assistance in this study is sincerely appreciated.

AL SHALAR

APPENDIX B

REPLY FORM

From:

To: LCDR Alexander Shalar, CEC, USN, SMC-2997, Naval Postgraduate School, Monterey, California 93940

Subj: Electrical Energy Allocation and/or Load Shedding Plan

Ref: (a) Your ltr dated

Encl: (1) Subject Plan(s)

1. In response to reference (a), the following is submitted:

a. Concerning subject plan:

☐ The plan(s) for our activity, copy submitted herein as Encl (1).

☐ A plan is currently in preparation. Estimate a copy will be sent to you by ______________________.

☐ Such a plan does not exist nor is it planned to write one in the near future.

b. The following person is our point of contact regarding electrical matters:

____ ______________

Name Phone number
Autovon preferred

c. Source of electricity (if commercial, state company; if some internally generated, state %):

d. Name industrial type facilities or other major power users at your activity (NARF, Shipyard, etc.):

e. Additional remarks (if any):

____

Signature - Title

____

Date

NAVAL AMMUNITION DEPOT
McAlester, Oklahoma 74501

McANADINST 11310.1 CH-1
092
4 January 1974

McANAD INSTRUCTION 11310.1 CHANGE TRANSMITTAL 1

From: Commanding Officer

Subj: Electrical Power Conservation Plan

Encl: (1) Revised enclosure (1)

1. Purpose. To transmit new enclosure (1).

2. Action. Remove enclosure (1) of the basic instruction and insert enclosure (1).

3. Cancellation. When required action has been taken.

J. E. CHAMBLISS

Distribution
B, D, M, N, O
09 (10 copies)

SUMMARY
OF
MASTER POWER CONSERVATION PLAN

ll percentages of power drops are based on a peak billing demand of 955 KW. Upon notification to reduce power, loads shall be dropped in he following sequence and amounts:

Phase 1 - 10%	395 KW
Phase 2 - 20%	791 KW

Consisting of Phase 1 plus 396 KW additional

Phase 3 - 33%	1305 KW

Consisting of Phase 2 plus 514 KW additional

Phase 4 - Strict Emergency	2305 KW

Consisting of Phase 3 plus 1000 KW additional

Enclosure (1)

MASTER PLAN

POWER CONSERVATION PROGRAM

FOR

NAD McALESTER, OKLAHOMA

ELECTRICAL POWER CONSERVATION

LOAD SHEDDING PROGRAM

FOR

NAD McALESTER, OKLAHOMA

ST PHASE

percent initial reduction of electrical demand	380 KW
1. Public Works - Run backwash pumps at water plant at night	30 KW
2. Fill Rocket tower at night only	30 KW
3. Transfer Building 14 battery charging from day shift to midnight shift	100 KW
4. Transfer Building 48 day shift to midnight shift	220 KW
	380 KW

ELECTRICAL POWER CONSERVATION

LOAD SHEDDING PROGRAM

FOR

NAD, McALESTER, OKLAHOMA

SECOND PHASE - A

2 percent reduction of electrical demand in emergency		760 KW
1. Public Works - Maintain load drop of Phase 1		380 KW
2. Ordnance - Reschedule Building #134 to swing shift		415 KW
3. Special Weapons - Eliminate all work in the environmental lab		70 KW
		865 KW
Adjusted load drop due to load cycling	SAY	760 KW

2

ELECTRICAL POWER CONSERVATION

LOAD SHEDDING PROGRAM

FOR

NAD McALESTER, OKLAHOMA

COND PHASE - B

percent reduction of electrical demand in emergency 1250 KW

1.	Public Works - Maintain load drop of Phase 1	380 KW
2.	Ordnance - Maintain Building #134 on swing shift	415 KW
3.	Special Weapons - Maintain discontinuation of environmental lab	70 KW
4.	Ordnance - Reschedule 20MM operations to swing	610 KW
5.	Special Weapons - Discontinue use of	
	Paint drying booth	50 KW
	Industrial oven	30 KW
		1555 KW

Adjusted load drop due to load cycling SAY 1250 KW

ELECTRICAL POWER CONSERVATION
LOAD SHEDDING PLAN
FOR
USNAD, McALESTER, OKLAHOMA

SECOND PHASE - C
EMERGENCY REQUIREMENTS ONLY PHASE

On notification to reduce power consumption to emergency levels, power loading shall be shed in the following manner:

1. General Schedule

   A. Maintain initial 10% drop

   B. Maintain 20% load drop

   C. Maintain 33% load drop

   D. Secure non-essential buildings

   E. Transfer to existing fixed generator power supply

   F. Transfer to portable generator supply

   G. Transfer to portable air compressors

   H. Shift work functions to night operation

   I. Implement emergency power program for all quarters area

   J. Implement miscellaneous power conservation measures

2. Detail requirements

   A. Maintain 10% drop — 380 KW
   (See first phase plan, immediate 10% load drop)

   B. Maintain 20% drop — 760 KW
   (See second phase plan, 20% reduction of electrical demand in emergency)

   C. Maintain 33% drop — 1250 KW
   (See second phase plan, 33% reduction of electrical demand in emergency)

   D. Secure non-essential buildings

   All buildings listed below shall be secured and electrical

power shall be discontinued. Necessary precatuions shall be taken to prevent freezing of water, steam and sewer lines as required. Buildings to be secured are:

Building	Area	Function
3	Administration	Recreation
8-A	Industrial	Quonset, supply
8-B	"	" "
12	"	Service station
13	"	Pump and valve house
19	"	Aux. power station
20	"	Paint and oil storage
24	"	Railroad shack
26	Main Gate	Training tank dressing room
33	" "	Shelter
34	" "	Incinerator
37	Ashland	Fuel oil pump house
38	"	Service station
44	Water Plant	Swimming pool/locker room
47	" "	Officers mess
55	Industrial	East classification yard
56	C-Tree & Stanton	West classification yard
57	Main Gate	Gas meter building
59	" "	Recreation Hall #2
105	40MM	Lunch and locker
129	Medium Caliber	" " "
136	" "	" " "
165	20MM	" " "
176	Bomb & Mine	" " "
183	" "	Powder metal storage
184	" "	" " "
186	" "	Cooling shed
187	" "	Filling building
188	" "	TNT storage
189	" "	Box emptying building
190	" "	Empty mine storage
191	" "	Lunch and locker
192	" "	Filling building
193	" "	TNT storage
194	" "	Box emptying building
195	" "	Cooling shed
204	Major Caliber	Fuse building
205	" "	Bomb-proof building
206	" "	Fuse assembly
207	" "	Boiler house
228	Motor Loading	Lunch and locker
356	Main Gate	Training tank
505	Administration	Ball field
1021	Main Gate	Quonset hut

Building	Area	Function
1022	Main Gate	Quonset hut
51SH101	C-Tree & Stanton	Inert storage
1031	Main Gate	Quonset hut, storage
1032	" "	" " "
1033	" "	" " "
1034	" "	" " "
1035	" "	" " "
1036	" "	" " "
1037	" "	" " "

Estimated total KW saved - 175 KW

E. Transfer to fixed generators 300 KW

The following buildings or areas shall be disconnected from commercial power and operated from fixed existing generators at their locations:

Building	Area	Function	KW
1	Administration	Communications	30
2 & 5	"	Barracks & Dispensary	175
6	Industrial	Fire Station	100
40	Wtr Plant	Lighting	12.5
104	40MM	Air comp.	175
105-B	"	Boiler room	15
108-B	Major Caliber	" "	15
110-B	" "	" "	15
136-B	Medium Caliber	" "	15
141-B	Medium Caliber	" "	15
165-B	20MM	" "	15
229-B	Motor Loading	" "	30
185-B	Bomb & Mine	" "	30
50PC	50PC	Area lighting	50
567	Spec Weapons	Fence lights	25
San. Fill	Motor Loading	Waste disposal	5

F. Portable generators 400 KW

The following buildings shall be disconnected and run wholly or in part from emergency portable generators as listed:

Building	Area	Function	KW
4	Administration	Cafeteria	50
14-A	Industrial	Shops	100
14	Industrial	Battery charging	175
14	"	Lighting	100
48	Ashland	Battery charging	175
48	Ashland	Battery charging	175

Building	Area	Function	KW
74	Apt	Housing	50
75	"	Housing	50
567	Bomb & Mine	Special Weapons (air comp)	100
106	Major Caliber	Printing and re-production	100
175*	Bomb & Mine	Ordnance	300

*The fixed 300 KW generator may be moved from its present location serving the entire "B" Plant area and be used to supply the 175 tar kettle only. Full production cannot be accomplished with the generator in its present location.

G. Portable compressors 500 KW

Air compressor units shall be disconnected from the buildings shown below and portable units provided as an emergency air supply:

Building	Area	Function	Existing CFM	Portable CFM
9	Industrial	Machine Shop	375	210
14-A	"	Shop	300	250
104-A	40MM	Production	343	500
127	Med. Cal.	"	800	500
131	" "	"	800	500
547	Mtr Loading	"	625	250
161	20MM	"	625	210
101-A	40MM	"	625	125
135	Med. Cal.	Case overhaul	150	125
140	" "	" "	100	125

H. Night operation

The following buildings shall be transferred to night operation, swing shift:

Building	Area	Function	KW
221	Motor Loading	Production	80
100	40MM	"	43
101-A	"	"	88
102	"	"	8
104	"	"	70.5
104-A	"	"	69
111	Major Caliber	"	23
209	Bomb & Mine	"	5

109	Major Caliber	Production	85
186	Bomb & Mine	"	7
455	Medium Caliber	"	6
		TOTAL	484.5
		SAY	480 KW

I. Housing Area Program

All quarters area personnel shall be notified to initiate an emergency power conservation program as follows:

(1) Use ranges, counter top units and oven as little as possible.

(2) Prepare breakfast prior to 0830 each morning.

(3) Prepare lunch without using electrical appliance, if possible, and only a minimum if necessary.

(4) Prepare dinner after 1600 each evening.

(5) Wash and dry clothes prior to 0830 or after 1600.

(6) Do not run air conditioning equipment with doors and windows open.

(7) Turn off all lights and appliances not in direct usage.

J. Miscellaneous power conservation

A miscellaneous electrical load shedding program shall be initiated as follows:

(1) Secure all exterior floodlights during daylight hours.

(2) Secure all building lights and office lights upon leaving. Turn on only while actually being occupied.

(3) Do not test large machinery or streetlighting during day shift.

(4) Set all central air units no lower than 76° F. and allow to run continually and cycle automatically.

(5) Each department be responsible for conserving power wherever possible.

3. Summary: Initiation of the above programs, allowing for load factors and cycling, should reduce the load KW by approximately 2250 KW or 60% of peak demand.

DEPARTMENT OF THE NAVY
NAVAL TRAINING CENTER
ORLANDO, FLORIDA 32813

CNTCORLINST 11310.1B
NTC/50E/OMD
3 June 1974

CNTC ORL INSTRUCTION 11310.1B

From: Commander, Naval Training Center, Orlando, FL

Subj: Electrical Power Load Shedding Plan

Ref: (a) CNO 291819Z MAY 70 PASEP NOTAL

Encl: (1) Electrical Power Load Shedding Plan
(2) Electrical Power Load Shedding Plan, Naval Hospital Orlando and Recruit Dispensary

1. Purpose. To establish an Electrical Power Load Shedding Plan as instructed by reference (a).

2. Cancellation. CNTCORLINST 11310.1A

3. Action

a. Upon notification from the Sixth Naval District, the Commander, Naval Training Center, will set the power load shedding condition as outlined in enclosure (1). The Naval Hospital Orlando and Recruit Dispensary will set the power load shedding condition as outlined in enclosures (1) and (2).

b. The NTC Commander, or his authorized representative, will notify each tenant command of the power load shedding condition set.

c. Each tenant commanding officer is responsible to effect compliance with the power load shedding condition set by the Commander, Naval Training Center.

d. The Public Works Department will be responsible for assisting each command in initiating conditions 1, 2, and 3.

M. A. Gore
M. A. GORE
Chief Staff Officer

Distribution: (See CNTCORLINST 5605.1H)
List I, Case 2
List II, Case 2
List III, Case 2

APPENDIX D

EXAMPLE OF A WELL-WRITTEN LOAD SHEDDING PLAN

ELECTRICAL POWER LOAD SHEDDING PLAN
NAVAL TRAINING CENTER
ORLANDO, FLORIDA

Condition 4

a. Reduce power consumption by 20%.

(1) All lighting in rooms with windows will be secured.

(2) All passageway lights will be secured.

(3) Lighting in rooms and buildings without windows will be used only as absolutely necessary.

(4) Electrical equipment (coffee makers, electric heaters, desk lamps, buffers, etc.) using 110 volt receptacles will be secured.

(5) Electric typewriters, calculators, duplicating/copying machines, etc., will be used only if absolutely necessary.

(6) All window air conditioning will be turned off.

Condition 3

a. Reduce power consumption by 33%.

(1) Follow Condition 4 instructions.

(2) All electricity to warehouses, except Building 148 (cold storage), will be turned off.

(3) Laboratories, machine shops, and workshops will be used only when absolutely necessary. Work will be limited as much as possible to office spaces.

(4) Place all electronic equipment in a standby status (AUWS ONLY).

Condition 2

a. Reduce power consumption to strict emergency requirements.

(1) All power will be turned off except in the following buildings:

218	148	1064	2036	3025	3122
246	216	2013	3014	3063	

D)

2002 - NTC Commander and OOD offices only

2010 - Security only

2026 - Food boxes only

2272 - Emergency generator work shop - as needed

2043 - Computer area (west end only)

Telephone Building - Start Emergency Generator

(2) Engage auxiliary drive units in the following buildings: (Engine Driven Pumps)

119 245 3013

(3) Start hospital emergency generators (2-100 KW)

<u>Condition 1</u>

a. Supply emergency power to the Center.

(1) Secure all main circuit breakers.

(2) Start emergency power units in buildings listed below that were not started in condition two:

2002	2013	2272	3039
2010	2036	3025	3122

D)

(3) Emergency power units, when available, will be rotated, as necessary, between the following buildings:

218 246 148 216 1064 2026 3014

(4) Engage auxiliary drive units in the following buildings:

119 245 513 2584 3013

ELECTRICAL POWER LOAD SHEDDING PLAN
NAVAL HOSPITAL & RECRUIT DISPENSARY
ORLANDO, FLORIDA

Condition 4

a. Reduce power consumption by 20%.

(1) Secure all passageway lights in BEQs and administrative buildings and spaces.

(2) Secure every other rampway light.

(3) Secure lights in any office or space not being utilized.

(4) Secure all window air conditioning units in BEQs and two window units in building 3091 (medical storage).

(5) Increase temperature settings for cooling to 80^{o} in all administrative buildings: (Buildings 3000, 3017, 3022, 3052, 3096, 3095, 3093, 3133) and BEQs (buildings 3001, 3126, 3128, 3129, 3130, 3132).

(6) Secure lighting in passageways and in all unused spaces in building 246.

(7) Secure one elevator in Building 246.

Condition 3

a. Reduce power consumption by 33%.

(1) Follow condition 4 procedures.

(2) Secure air conditioning systems in the following buildings at 1600 and re-activate at 0730 on workdays: 3002, 3021, 3023, 3024, 3043, 3051, 3052, 3060, 3095, 3096, 3086.

(3) Secure air conditioning systems in buildings 3133 and 3134. Activate building 3134 on blood donor days only. Shift classroom functions from building 3133 to building 3052.

ENCLOSURE (2)

(4) Determine patient loading and investigate possibility of combining wards to allow securing ward buildings.

(5) Secure all TV sets in wards and clinics.

(6) Increase temperature settings for cooling to 80° in all administrative buildings (buildings 3000, 3017, 3022, 3052, 3096, 3095, and 3093).

(7) Conduct on-line test of hospital emergency power system.

(8) Secure TV sets in building 246.

(9) Secure elevators in building 246 (except for movement of nonambulatory patients).

(10) Determine patient loading in building 246 and investigate possibilities of consolidating wards and/or transferring patients to Naval Hospital to allow securing air conditioning in dispensary wards.

Condition 2

a. Reduce power consumption to strict emergency requirements.

(1) Follow conditions 3 and 4 procedures where applicable.

(2) Secure electrical consumption in the following buildings:

3001	3043	3090	3127
3002	3050	3092	3128
3017	3051	3093	3129
3021	3052	3094	3130
3022	3060	3095	3132
3023	3070	3096	3133
3024	3087	3126	3134
			3085

3086 (except reefer)
3091 (except reefers)
3094 (ambulance crews dispatched from 3071)
3071 (second floor only)

(3) Reduce hospital operations as follows:

(a) Cancel elective surgery.

(b) Cancel non-emergency radiology examinations.

(c) Cancel clinic appointments except for urgent cases.

(d) Cancel elective admissions.

(4) Food Service Division adjust menus where possible to permit minimal food preparation. Develop procedures for providing emergency rations to non-patient personnel.

(5) Conduct on-line test of hospital emergency power system.

(6) Transfer inpatients in building 246 to hospital if possible.

(7) Secure electrical consumption in all spaces in building 246 except emergency room and occupied wards.

Condition 1

a. Emergency Power Only

(1) Follow conditions 2, 3, and 4 where applicable.

(2) Activate emergency power system.

(3) Activate radiology emergency power system.

(4) Suspend hospital operations except as necessary to provide care for inpatients, and urgent and emergency outpatients.

(5) Food Service Division provide emergency rations for non-patient personnel. Provide patient menu requiring minimal food preparation.

(6) Secure Building 246 and transfer all dispensary functions to Naval Hospital (this action must depend upon estimated period of time that condition 1 will prevail).

EXAMPLE OF A WELL-WRITTEN LOAD SHEDDING PLAN

DEPARTMENT OF THE NAVY
NAVAL WEAPONS STATION
SEAL BEACH, CALIFORNIA 90740

IN REPLY REFER TO
WPNSTASBINST 11300.2
09B:RCO/CVM:mpf

9 JUL 1973

WPNSTASB INSTRUCTION 11300.2

Subj: Electrical Power Load Reduction

Ref: (a) WPNSTASB INST 11300.1A

1. Purpose. To establish and maintain a plan for reducing the Station's immediate power demand from Southern California Edison Company (SCE).

2. Applicability. This instruction applies to Mainsite only and is effective all year. Officers in Charge at Fallbrook and FMSAEG Annexes shall develop similar implementing directives as necessary.

3. Background.

a. As previously stated in reference (a), efficient use of electric power is both economical and necessary. The Southern California area faces an imminent power shortage due to both inefficient power usage and increase in power demand resulting from growth and new construction. The electric utilities are currently at maximum output and cannot provide for significant new demand. With electric demand exceeding new plant construction, we must take necessary measures to assure that power is used efficiently, and establish contingency plans for temporarily cutting back consumption during periods of high area demand. Load shedding is a contemporary necessity--it may be accomplished by simply turning off unnecessary lights, or physical disconnection of complete circuits. The load shedding program delineated herein specifies procedures to insure an effective meeting of our power conservation responsibilities.

b. The current peak load power demand for the Station is about 2440 kilovolt-amperes (KVA). By implementing power conservation and load shedding programs, the Station's immediate power demand from SCE can be temporarily reduced by approximately 550 KVA (22% of peak load) and the future demand can be reduced by 1000 KVA (41% of peak load). This is not a curtailment of permanent power supply, but rather a shedding of load when required by over-demand upon commercial SCE generation facilities.

c. The power load removed from the SCE system will be supplied by Station emergency generators, thereby lowering the overall Station demand from the supplier. The reduction of future Station power demand is based on the utilization of existing railcar-mounted emergency generators which have not yet been connected into the Station's power distribution system.

APPENDIX E

4. Load Shedding Plan.

a. Currently existing and connected emergency generators installed at Buildings 88, 850 and 879 will be utilized when the Station is notified to reduce peak demand by the supplier. These generator units are rated at 185, 75 and 125 KVA respectively. Since they are not used currently to 100% of rated capacity, resultant load reduction to SCE will be approximately 200 KVA.

b. The Administration Area 4160 volt electrical distribution system will be isolated, and three 100 kilowatt (KW) portable generators will be installed to pick up this load. They will be installed at Buildings 16, 26 and 206 where transformers are presently located. The estimated load reduction to SCE for the use of portable emergency generators is 250 KVA.

c. Heads of Departments shall reduce power consumption to an absolute minimum, continuing to use power only to maintain necessary personnel support functions and meet immediate mission requirements.

5. Action.

a. Heads of Departments, subordinate activities, and tenant commands shall establish the following load shedding/power conservation means:

(1) Observe conservation methods of reference (a).

(2) Develop departmental load shedding plans with a target reduction of 25% in energized circuit loads.

(3) Designate specific personnel to secure circuits and insure they remain secured.

(4) Prohibit use of all electric heaters during periods of power shortage; secure all electrical equipment not directly related to accomplishment of mission during power shortage; secure all lighting and air conditioning units which can be temporarily secured, but without which minimum equipment environmental conditions can be maintained.

(5) Prohibit energizing of all compressors, electric motors, and similar high power demand equipment not in use at the time of power shortage notification.

(6) Forward to the Executive Officer (copy to the Public Works Officer) by 1 August 1973 written departmental load shedding plans implementing the provisions of this section, paragraph 5a.

b. Upon notification of a power shortage by SCE, the Public Works Department as electrical load shedding coordinator will:

(1) Notify Station departments of power shortage and requirement for implementing their load shedding plans.

(2) Activate emergency power generators and disconnect commercial power feeds to affected buildings; maintain proper operation of the generators.

(3) Secure air conditioners identified to be non-vital in departmental load shedding plans.

(4) Shutdown compressors and electrical motors not needed for immediate mission production.

c. Load shedding shall remain in effect until notification from the Public Works Department to secure from this condition. Any exceptions to load shedding plans will be made by the Executive Officer; unauthorized deviation from load shedding plans defeats the purpose of this emergency measure, and as such is strictly prohibited.

F. R. Cassilly

F. R. CASSILLY

DISTRIBUTION:
List B

OPNAV 5216/144 (REV 6 70)
S N 0107 778 3099
DEPARTMENT OF THE NAVY

Memorandum

0921:CLF:mpf
DATE: 15 Oct 1973

FROM 0921

TO Public Works Officer
VIA (1) 092
(2) 09B

SUBJ Load Reduction Exercise; Results of

1. The electrical power load reduction plan as outlined in WPNSTASB INST 11300.2 was implemented on 4 October to obtain information as to validity and practicability of the plan. The exercise began at 0900 and was completed by 1500.

2. The electrical load on the Southern California Edison Company (SCE) system at 0900 was 1710 KVA. At 1300, the SCE load was 1070 KVA. The load reduction on the SCE System was 640 KVA. A reduction of 550 KVA was projected for this exercise. Emergency generators picked up approximately 410 KVA of the 640 KVA removed from the SCE system. The remaining 230 KVA (640-410) represents load removed from the Station's system by the implementation of various Department load shedding/power conservation plans.

3. Electric Shop personnel monitored the major buildings to observe and/or assist the building supervisors. Comments by the Shop personnel are:

a. The Public Works air compressor, building 233, could be taken out of service and replaced by existing, portable diesel driven equipment. Estimated 60 KW of electrical load would be removed from the system.

b. Building 88 (Code 20) was put on the installed emergency generator. The building personnel were very cooperative.

c. Building 89 (Code 30) personnel not informed of exercise and had no plan. Personnel turned off 6 lights.

d. Building 403 (Code 20) north end lights could have been secured.

e. Building 411 (Code 70) could turn off some lights in areas not in use.

f. Building 433 (Code 30) had no plan. Lighting could be reduced.

g. Building 410 (Code 20) electric water heater and refrigerator (nothing in it) could be secured.

h. Building 94 (Code 20) lights and refrigerator (empty) could be secured.

i. Building 226 (NPPS) lighting system should be divided so sections could be turned off.

APPENDIX F

j. Building 229 (Code 02, 09, 20) Boiler room was locked and lights left on. Lighting system (Code 20) should be subdivided so sections could be turned off. Exhaust fan in back room could have been secured.

k. Building 915 (Code 20) Security was on, and building could not be inspected.

l. Overall cooperation was very good.

4. The load reduction achieved during the exercise exceeded the projected reduction and the Station Departments are to be commended. The response and interest demonstrated by the Public Works Shop personnel was very good.

Very respectfully,

C. L. FREDERICKS

APPENDIX G: TYPICAL UTILITIES CONSERVATION ORGANIZATION AND DUTIES

CO - Commanding Officer. Issues major policy statements in the form of instructions, notices, etc, dealing with Utilities conservation, Provides full backing to conservation effort.

UCO - Utilities Conservation Officer. This is a specific duty of the Public Works Officer. He develops and maintains the organizational framework in which the CO's utilities conservation policies are put into action. Also, his Public Works Department personnel maintain records and publish periodic reports to the tenant activities informing them of the effectiveness of their individual conservation efforts.

ACO - Activity Conservation Officer. The officer in charge of each tenant activity appoints an Activity Conservation Officer. The appointment is a collateral duty and is made in writing, specifying the duties and responsibilities involved and the minimum amount of time to be spent per week in this duty. The name and phone number of the person assigned and a copy of the appointing letter are provided to the UCO.

BCM - Building Conservation Monitor. Each building or facility should be assigned a utilities conservation monitor by the ACO. If there is already a person

assigned to coordinate maintenance matters for the building, this individual would be the logical BCM as well. The name and phone number of the person assigned should be provided the UCO and ACO. Also, these data along with a general description of the BCM's duties should be prominently displayed in each building.

UCM - Utilities Conservation Monitor. This individual works for the Public Works Officer and has direct access to him (no intermediate supervisors, with possible exception of Executive Officer). The UCM is responsible for patrolling the base and issuing "Energy Waste Critations" to individual Building Conservation Monitors (BCM's) for any wasteful practices observed in their area of responsibility. The UCM keeps a record of such violations and provides a summary report to the Public Works Officer on a periodic basis (say monthly).

UCC - Utilities Conservation Committee. Committee meeting are held monthly and are chaired by the UCO (Public Works Officer). The remaining members of the Committee are the ACO's, the UCM, and the Public Works Utilities Department representative. The latter two individuals present the status of each tenant activity's efforts in conservation as observed and recorded by Public Works. ACO's are afforded the opportunity to concur, disagree or otherwise comment on the reports. All committee members are encouraged to make constructive

recommendations concerning measures that could be taken to increase conservation on the base.

Commanders' Meetings - These are the meetings that every base commander has with the officers in charge of tenant units, about once a month. The UCO (Public Works Officer) should use these meetings as a forum in which to present a brief summary of each tenant's performance in the area of utilities conservation. It should be kept foremost in the minds of the officers in charge that the primary responsibility for utilities conservation is theirs, and not the Publis Works Officer's. (See NAVFAC MO-305 for additional discussion.)

Note: Portions of the Conservation Organization and Duties described above are similar to the organization and duties recommended in Section 4 of the Utilities Management Manual, NAVFAC P-96. Said manual should be consulted when developing a utilities management system.

TABLE 2-3 (1 of 3)
Usage Factors for Energy and Demand Calculations

Navy Code	Usage Factor For Energy		Usage Factor For Demand		Navy Code	Usage Factor For Energy		Usage Factor For Demand	
	Area	Load	Area	Load		Area	Load	Area	Load
121-All	.21	.09	.64	.28	216-60	.43	.14	1.19	.38
122-All	.21	.09	.64	.28	216-Other	.39	.14	1.06	.38
123-All	.22	.08	.73	.26	217-All	.23	.09	.60	.24
125-All	.28	.12	.94	.41	218-10	.37	.16	.94	.41
126-All	.02	.03	.07	.11	218-20	.25	.09	.70	.25
131-40	.99	.33	1.32	.44	218-40	.15	.07	.46	.22
131-Other	1.38	.46	1.50	.50	218-50	.31	.14	.81	.37
133-40	.29	.15	.74	.39	218-Other	.27	.15	.68	.38
133-70	1.38	.46	1.47	.49	219-10	.19	.07	.57	.21
133-Other	.87	.46	.95	.50	219-Other	.09	.05	.31	.18
141-10	.42	.22	.82	.43	221-All	.26	.08	.73	.22
141-20	.12	.05	.25	.11	222-All	.20	.07	.59	.21
141-30	.32	.19	.82	.48	223-All	.11	.07	.26	.17
141-40	.55	.22	1.08	.43	225-30	.12	.05	.29	.12
141-60	.30	.13	.94	.41	225-Other	.17	.05	.41	.12
141-Other	.27	.16	.71	.42	226-10	.46	.17	1.18	.42
159-All	.15	.08	.40	.21	226-15	.28	.10	.70	.25
171-10	.24	.12	.64	.32	226-20	.22	.08	.62	.22
171-20	.25	.12	.61	.29	226-35	.22	.08	.62	.22
171-30	.11	.14	.36	.45	226-40	.22	.08	.62	.22
171-40	.08	.04	.32	.17	226-55	.22	.08	.62	.22
171-Other	.12	.07	.39	.23	226-65	.22	.08	.62	.22
211-10	.53	.14	.12	.32	226-Other	.23	.10	.62	.27
211-30	.68	.18	1.75	.46	227-10	.35	.14	.88	.35
211-40	.26	.08	.73	.22	227-20	.35	.14	.88	.35
211-50	.57	.13	1.32	.30	227-40	.35	.14	.88	.35
211-60	.26	.08	.73	.22	227-Other	.66	.20	1.65	.50
211-70	.26	.08	.73	.22	228-10	.29	.09	.77	.24
211-Other	.13	.08	.40	.25	228-Other	.66	.20	1.65	.50
212-All	.20	.07	.59	.21	229-10	.10	.08	.39	.30
213-30	.18	.08	.46	.21	229-20	.18	.14	.57	.44
213-Other	.52	.20	1.22	.47	229-30	.18	.14	.57	.44
214-All	.52	.14	1.37	.37	229-40	.08	.09	.24	.27
215-All	.48	.17	1.32	.47	229-Other	.42	.13	1.02	.32
216-10	.22	.08	.62	.22	310-20	.46	.19	.98	.41
216-20	.22	.08	.62	.22	310-30	.03	.01	.10	.04
216-30	.20	.07	.59	.21	310-44	.43	.10	.86	.20
216-40	.12	.10	.37	.31	310-58	.46	.19	.98	.41
216-50	.22	.08	.62	.22	310-68	.12	.07	.27	.16

TABLE 2-3 (2 of 3)
Usage Factors for Energy and Demand Calculations

Navy Code	Usage Factor For Energy		Usage Factor For Demand		Navy Code	Usage Factor For Energy		Usage Factor For Demand	
	Area	Load	Area	Load		Area	Load	Area	Load
310-Other	.22	.10	.51	.23	730-30	.48	.23	.92	.44
421-All	.16	.18	.43	.48	730-35	.65	.18	.86	.24
422-All	.16	.18	.43	.48	730-40	.13	.16	.31	.39
423-All	.16	.18	.43	.48	730-45	.21	.08	.55	.21
431-All	.15	.17	.41	.45	730-50	.17	.10	.61	.36
432-All	.20	.22	.41	.46	730-55	.18	.10	.65	.36
441-20	.16	.23	.32	.45	730-60	.19	.10	.67	.35
441-30	.13	.18	.34	.48	730-65	.46	.27	.88	.52
441-40	.13	.18	.31	.44	730-70	.24	.14	.58	.34
441-Other	.12	.20	.31	.51	730-Other	.20	.14	.48	.34
442-10	.24	.16	.60	.40	740-10	.09	.10	.23	.26
442-20	.32	.19	.83	.49	740-14	.40	.18	.92	.42
442-30	.27	.16	.68	.40	740-18	.49	.18	1.30	.48
442-40	.27	.16	.68	.40	740-23	.35	.16	.86	.39
442-50	.20	.13	.57	.38	740-26	.16	.12	.46	.35
442-60	.24	.16	.60	.40	740-30	.25	.09	.78	.28
442-Other	.27	.18	.72	.48	740-33	.56	.18	1.49	.48
510-All	.26	.20	.54	.27	740-36	.29	.08	.68	.19
520-All	.38	.21	.50	.28	740-40	.17	.10	.43	.25
530-10	.30	.08	.70	.19	740-43	.41	.24	.77	.45
530-20	.20	.08	.48	.19	740-46	.17	.10	.43	.25
530-Other	.45	.18	1.03	.41	740-50	.18	.08	.46	.20
540-All	.26	.08	.61	.19	740-53	.37	.22	.65	.38
550-All	.23	.11	.53	.25	740-54	.30	.16	.70	.37
610-All	.45	.16	1.09	.39	740-56	.90	.06	2.25	.15
620-All	.74	.23	1.34	.42	740-60	.27	.10	.70	.26
690-All	.17	.10	.61	.36	740-63	.34	.12	.81	.29
711-All	.09	.09.	.22	.22	740-66	.34	.12	.81	.29
712-All	.10	.10	.25	.25	740-70	.27	.10	.70	.26
714-All	.01	.01	.02	.04	740-73	.44	.26	.82	.48
721-20	.34	.14	.53	.22	740-76	.44	.26	.82	.45
721-Other	.35	.15	.58	.25	740-80	.11	.14	.27	.34
722-20	.26	.16	.56	.35	740-83	.46	.27	.88	.52
722-Other	.22	.16	.50	.36	740-86	.22	.16	.56	.40
723-10	.65	.18	.83	.23	740-88	.36	.24	.77	.51
723-20	.25	.18	.57	.41	740-Other	.08	.07	.23	.19
723-30	.21	.08	.55	.21	750-All	.08	.19	.18	.44
723-Other	.01	.01	.02	.04	811-20	.56	.35	.67	.42
724-30	.31	.13	.58	.24	811-60	.07	.06	.20	.17
724-Other	.18	.10	.43	.24	811-Other	.61	.38	.72	.45
730-10	.07	.05	.14	.11	821-10	.35	.22	.51	.32
730-15	.32	.23	.56	.40	821-20	.42	.26	.62	.39
730-20	.26	.12	.59	.27	821-30	.42	.26	.62	.39

EXHIBIT 2-4 (3)

Navy Code	Usage Factor For Energy		Usage Factor For Demand		Navy Code	Usage Factor For Energy		Usage Factor For Demand	
	Area	Load	Area	Load		Area	Load	Area	Load
821-50	.30	.19	.54	.34	890-40	.18	.18	.44	.44
821-Other	.25	.19	.44	.34	890-Other	.17	.19	.41	.46
831-All	.10	.12	.23	.29					
832-All	.15	.19	.29	.36	Street				
833-10	.09	.10	.29	.32	Lighting	–	.44	–	–
833-50	.04	.18	.10	.48					
833-Other	.15	.07	.46	.21	Security				
841-All	.27	.14	.79	.41	Lighting	–	.44	–	–
842-20	.18	.14	.53	.41					
842-Other	.02	.08	.09	.29	Airfield				
890-20	.14	.14	.37	.37	Lighting	–	.21	–	–

Note: For Navy Codes where double shift operations occur; the usage factors for energy area & load should be multiplied by 1.28. Caution: Do not use where less than 16 hours operation occur.

TABLE 2-4
Normal Connected Load

FEEDER #1							
BUILDING	CODE	AREA (X1000 SF)	PRINCIPAL CONN. LOADS : (2 kw-hr)	USAGE FACTORS		TARGETS	
				DEMAND	ENERGY	DEMAND	ENERGY
28-PUBLIC WORKS	219-10	21.06		.57	.19	12.0	4.0
AIR COMPRESSORS (2) at 20 kw			40 kw	.21	.07	8.40	2.80
MOTOR VENT FANS (2) at 6.5			13	.21	.07	2.70	0.91
Oil Pumps (2) at 2			4	.21	.07	0.84	0.28
Circulating Water			8	.21	.07	1.68	0.56
31-MAINTENANCE SHOP	217-10	9.00		.60	.23	5.40	2.07
EXHAUST FANS (2) at 2.5			5	.24	.09	1.20	0.45
DRILL PRESS			8	.24	.09	1.92	0.72
CRANE			50	.24	.09	12.00	4.50
MG SETS (2) at 50			100	.24	.09	24.00	9.00
VIBRATION TESTER			(see special loads)				
						70.14 kw	25.29 kw

TABLE 2-5
Special Loads

	RATING (KW)	HRS OPERATION[1]	KWH	KW DEMAND
VIBRATION TESTER	60	4.5	270	60
PUMPS, DRY DOCK NO. 2 (4 at 80)	320	8.0	2560	2560
TOTAL			2830	2560[2]

[1]Total hours operation during target period - one month.

[2]Assume operations planned to avoid simultaneous operation of pumps and special test equipment.

TABLE 2-6
Outdoor Lighting - Feeder No. 2

No. of Lamps (1)	Rating Watts (2)	Total (kw) (3)	Avg. Hrs/Day Period (4)	Avg. Hrs/Day Hours (5)	Number of Days Total in Period (6)	Number of Days Excluded (7)	Number of Days Total Operating (8)	Total Hrs in Period (5) X (8)	Target Kw-hr (3) X (9)
South Parking Lot									
30	600	18	Sunset/ 12M	6.5	30	9 (Sat., Sun., Hol.)	21	137	2466
Street - Sector No. 2									
55	550	30	Sunset/ Sunrise	13	30	-	30	390	11700
Security - Missile Storage									
10	400	4	Sunset/ Sunrise	13	30	-	30	390	1560
TOTAL TARGET KW-HR									15726

TABLE 2-7 (1 of 2)
Summary Calculations (For 30-Day Period) - Feeder #1

I. ENERGY TARGET				
SERVICE & NORMAL CONNECTED LOADS (Table 2-4)				
AVE. POWER		25 kw		
No. of Hrs. In Period	×	720		
TARGET kw-hr			18,000 kw-hr	(1)
SPECIAL LOADS (Table 2-5)			2,830 kw-hr	(2)
OUTDOOR LIGHTING (Table 2-6)			15,726 kw-hr	(3)
ELECTRIC HEATING				
BTU (See Chapter 4, Table 4-2, Item 1)		32×10^{6}		
Conversion factor	×	293×10^{-6}		
			9,376 kw-hr	(4)
TOTAL (1) thru (4)			45,932	(5)
LINE & TRANSFORMER - LOSSES 6% of (5) or calculated			2,756	
TARGET kw-hr			48,688 kw-hr	

TABLE 2-7 (2 of 2)
Summary Calculations (For 30-Day Period) - Feeder #1

II. DEMAND TARGET		
SERVICE & NORMAL CONNECTED LOADS (Table 2-4)	64 kw	(1)
SPECIAL LOADS (Table 2-5)		
Vibration Tester	60 kw	(2)
NOTE: Assume Dry Dock Pumps are run during offpeak hours, per Activity Conservation policies.		
OUTDOOR LIGHTING (Table 2-6)	42 kw	(3)
ELECTRIC HEATING, from DD1342, Property Record Card	38 kw	(4)
NOTE: Use full rated or metered capacity, if full plant cycles on even during periods of limited BTU consumption.		
TOTAL, (1) thru (4)	204 kw	(5)
LINE & TRANSFORMER LOSSES (0.12 X (5) or calculated)	24 kw	
TARGET DEMAND	228 kw	

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